AD-A156 173 USNS HAYES (T-AGOR-16) SUMMARIZED RESULTS OF SLOW-SPEED 1/1
TRIALS JULY - AUGUST 1976(U) NAVAL RESEARCH LAB
WASHINGTON DC G O THOMAS JUN 77 SBI-AD-E001 647

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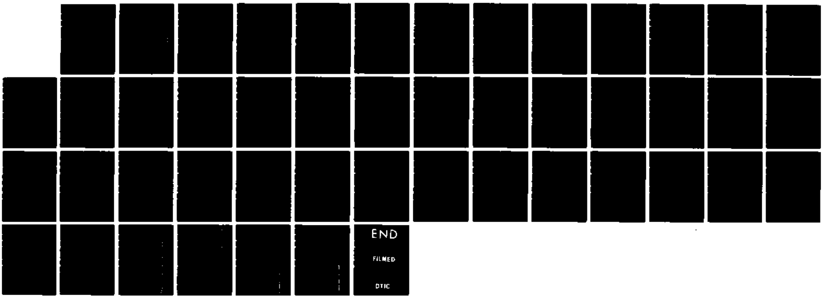

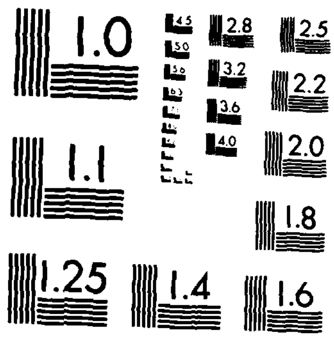

MICROCOPY RESOLUTION TEST CHART
NATIONAL BUREAU OF STANDARDS-1963-A

1677

5805
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NAVAL RESEARCH LABORATORY
WASHINGTON, D.C. 20375

IN REPLY REFER TO:

AD-A156 173

USNS HAYES (T-AGOR-16)

SUMMARIZED RESULTS
of
SLOW-SPEED TRIALS

July - Aug 1976

by

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Ocean Technology Division

June 1977

SUMMARIZED RESULTS OF THE SLOW-SPEED TRIALS.

Slow-speed trials were conducted on the USNS HAYES between 29 July and 1 August 1976 in Cardigan Bay off the coast of Wales in the Irish Sea.

Enclosure 1 is a copy of the operations plan for the cruise. This plan was later modified slightly as is shown in the revised overall schedule of Table 1 and the detailed schedule of Table 2.

The overall objective of the cruise was to establish slow-speed operational and maneuverability characteristics of HAYES in a seaway.

Records kept of the cruise included:

a. a detailed log
b. weather summaries from the bridge
c. plots of the ship course
d. computerized documentation of ship heading, propeller pitch, rudder angle, shaft rpm, shaft torque and shaft horsepower
e. handwritten documentation of propeller pitch, shaft revs, speed log data and rudder angles.

Details of the weather on the days of the cruise were summarized in the ship's log, a copy of which is attached as Appendix 2. For further interpretation of the results contained in the ship tracks, Table 3 has been compiled summarizing tide current magnitude and direction data taken from British Admiralty tide reference material.

Details of the computer printout and the manually recorded data will not be included in this summary but are available for inspection if required.

Aux. Engine Tests

The first test was made on 30 July and included auxiliary engines driving both shafts.

Figure 1 is the ship track which resulted from the auxiliary engine test.

Throughout the tests the sea was slight between 2-3 foot waves. Wind varied up to 10 knots.

Two forms of propeller power control are possible. In the programmed mode, (which is the only means available on the bridge,) propeller pitch changes are first made up to the maximum value while propeller revs are held constant, ~~at 70 rpm~~. Upon reaching the maximum pitch further increases of power are provided by maintaining the pitch constant and increasing the revolutions per minute ~~from 70 up~~ to the maximum value, ~~about 140~~.

TABLE 1

SLOW-SPEED TRIALS
OVERALL SCHEDULE

Friday 30 July

DST*	
0800 ETA	OP Area
0800-1000	Slow-speed using auxiliaries. Both main engines off.
1000-1130	One main engine on, other propeller not spinning
1130-1930	8 hours crawl-speed on main engines
1930-2130	Make smoke
2130-1330	16 hours crawl-speed on main engines

Saturday 31 July

1330-1530	Make smoke
1530-1530	24 hours crawl-speed on main engines

Sunday 1 August

1530-2000	Enroute
2000	ETA Milford Haven

* Daylight Saving Time DST = Z + 1

TABLE 2

SLOW-SPEED TRIALS

DETAILED SCHEDULE

7/30 0800* - 7/30 1000 Slow-speed trials and maneuvers using ausiliary engines only. Programmed, direct and manual controls will be used. Both main engines will be off.

7/30 1000 - 7/30 1130 One main engine (other engine off) slow-speed trials and maneuvers. Programmed, direct and manual controls will be used and the effects of idling speed reduction and pitch variation will be evaluated. Independent rudder control to increase drag will be studied.

7/30 1130 - 7/30 1930 Two engine slow-speed trials and maneuvers. Programmed, direct and manual engine control will be used to reduce shaft speeds below 70 rpm and propeller pitch below 5°. The effect of one prop running with less pitch than the other or reverse pitch, with rudder compensation, will be evaluated.

7/30 1930 - 7/30 2130 Smoke

7/30 2130 - 7/30 2300 1/4 knot trials

7/30 2300 - 7/31 0800 1 knot into the sea

7/31 0800 - 7/31 1130 1/4 knot trials

7/31 1130 - 7/31 1200 1 knot into the sea

7/31 1200 - 7/31 1330 1/4 knot trials

7/31 1330 - 7/31 1530 Smoke

7/31 1530 - 7/31 1700 1/2 knot trials

7/31 1700 - 7/31 1730 1 knot into the sea

7/31 1730 - 7/31 2300 1/2 knot trials

7/31 2300 - 8/1 0800 1 knot into the sea

8/1 0800 - 8/1 1130 1 knot trials

8/1 1130 - 8/1 1200 1 knot into the sea

8/1 1200 - 8/1 1530 2 knot trials

* DST = Z + 1

TABLE 3

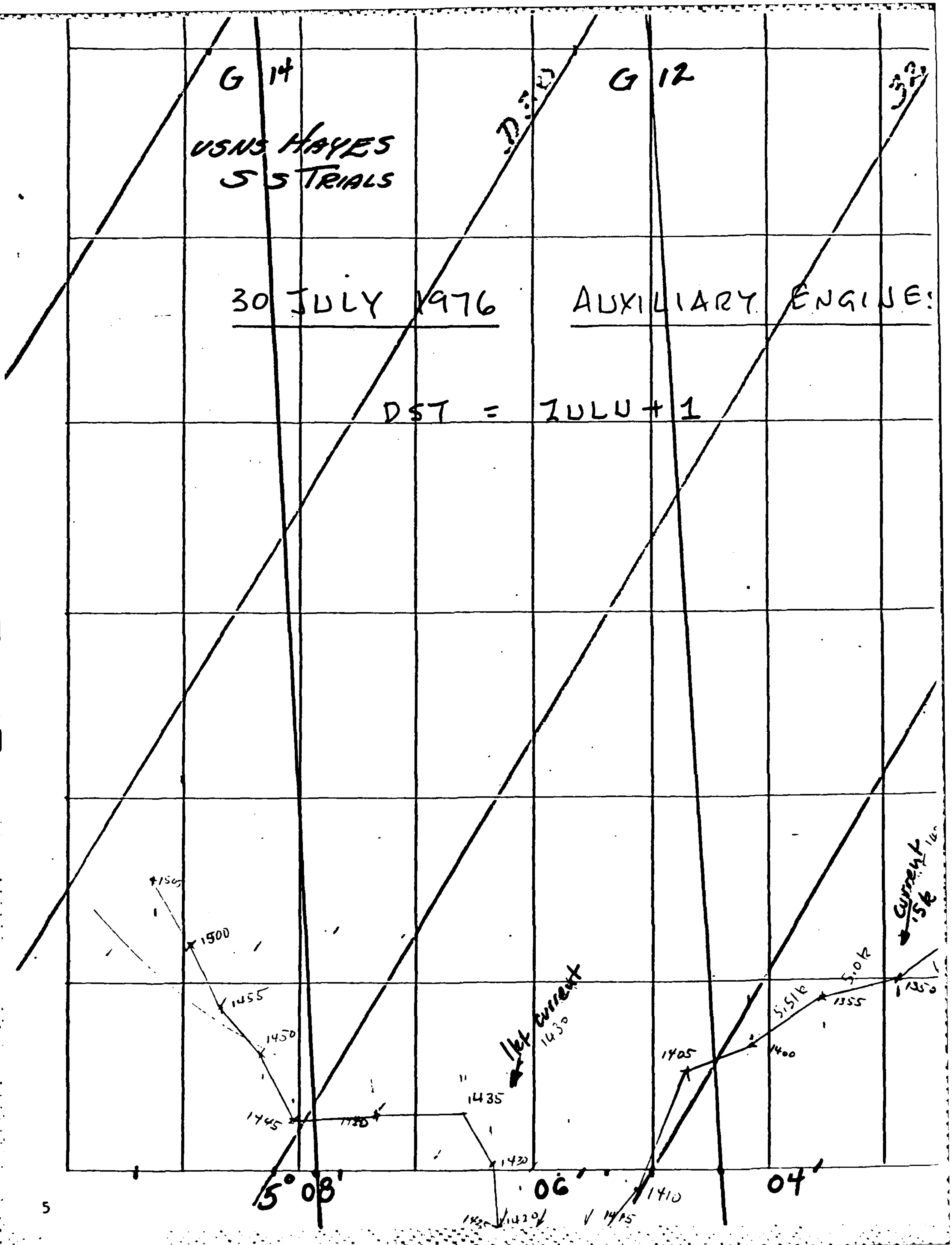
TIDAL CURRENT SPEED & DIRECTION

6 HRS BEFORE & 6 HRS AFTER HITIDE @ DOVER

LOCATION - $52^{\circ}20'N-5^{\circ}W$

	HOURS (ZULU)	DIRECTION (DEGREES)	SPEED (KNOTS)	
(After)	+6	45	.3-.5	
	+5	225	1.0-1.3	
	+4	180	1.0	
	+3	160	1.0	
	+2	165	2.0	
	+1	190	1.3	
Hi	0	190	0.4	HiTide Dover
(Before)	-1	20	0.8	
	-2	20	1.0-1.5	
	-3	0	2.1	
	-4	0	1.5	
	-5	0	1.7	
	-6	45	0.5	

High tide at Dover: 30 July 76 0047Z and 1309Z
31 July 76 0132Z and 1353Z


G 14
G 12
USNS HAYES
SS TRIALS
30 JULY 1976
AUXILIARY ENGINES
DST = ZULU + 1
1500
1455
1450
1445
1435
1430
1425
1420
1405
1400
1410
1415
1355
1350
5.5 K
5.0 K
1 kt current
Current .5 k
5° 08'
06'
04'

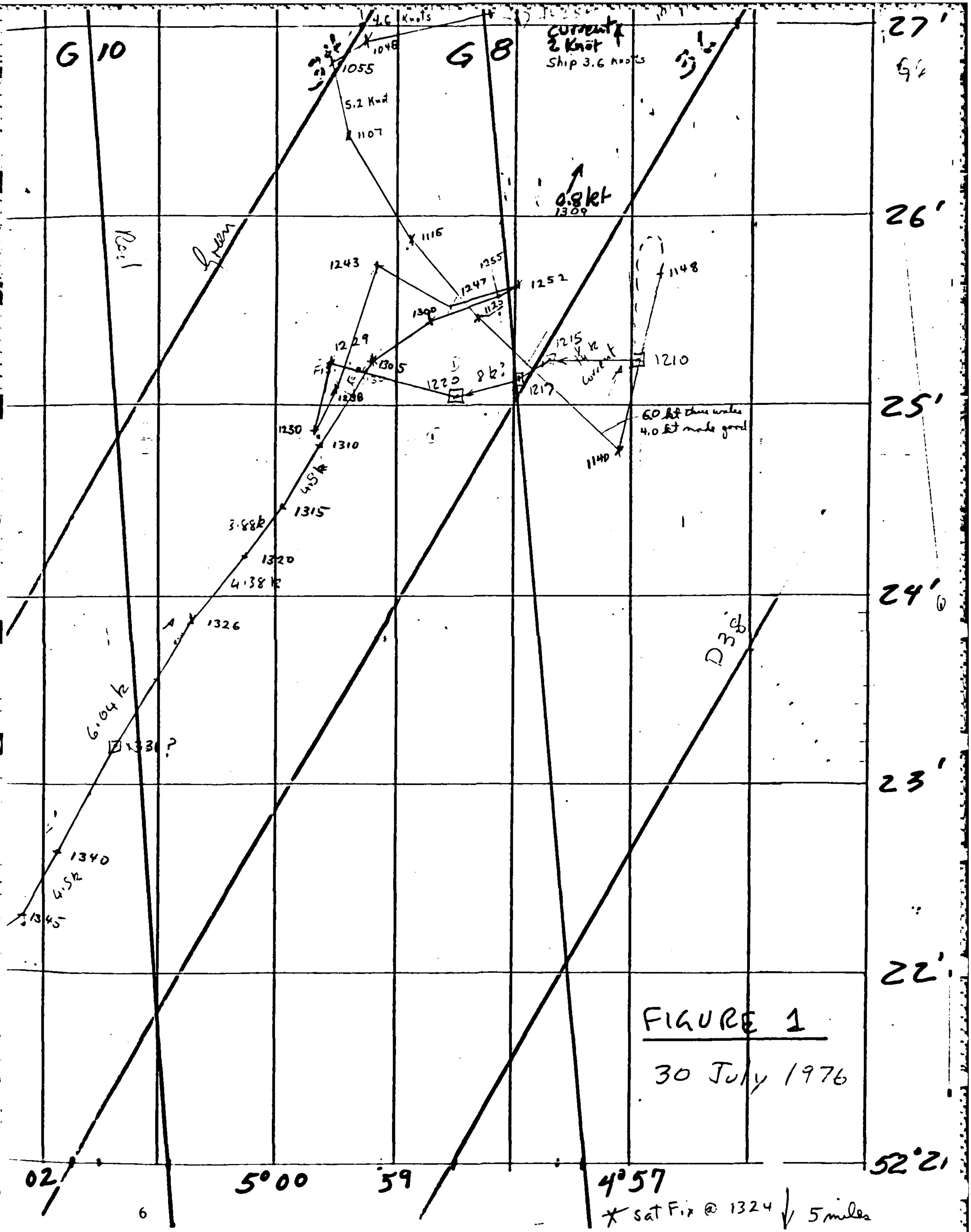


FIGURE 1

30 July 1976

Control of the auxiliaries in the programmed mode was tried first. In the programmed mode of the auxiliaries the maximum pitch allowable is 16 degrees at 50 rpm. This was insufficient to provide speed or maneuverability (see navigation chart Figure 1). Next, control of the auxiliaries was switched to the direct mode. In the direct mode, which can only be activated from the engine control station, a rotatable control is provided for regulating the pitch and rpm of each propeller individually. The limiting condition here is the exhaust temperature. The maximum exhaust temperature to which the chief engineer was prepared to allow the auxiliary engines to rise was 550°F.

In the direct mode the pitch was increased up to 22-1/2 degrees. The exhaust temperature was still below 470°F. At 27-1/2 degrees pitch both the lube oil and the exhaust temperature climbed too high and it was necessary to return to 25 degrees pitch as a working maximum. At this level of propeller pitch the exhaust temperature stabilized at 513°F and the speed through the water at 5.6 knots. At this limit of the auxiliaries in the direct mode the ship answered well to the rudder and pivoted 180° at 1° per second.

In reverse, the engine speed began to drop off at 15° pitch which was then taken to be the maximum reverse pitch.

A summary of the auxiliary engine trials are as follows:

a. the maximum forward pitch is 25°
b. the maximum reverse pitch is 15°
c. maximum rpm is 50.

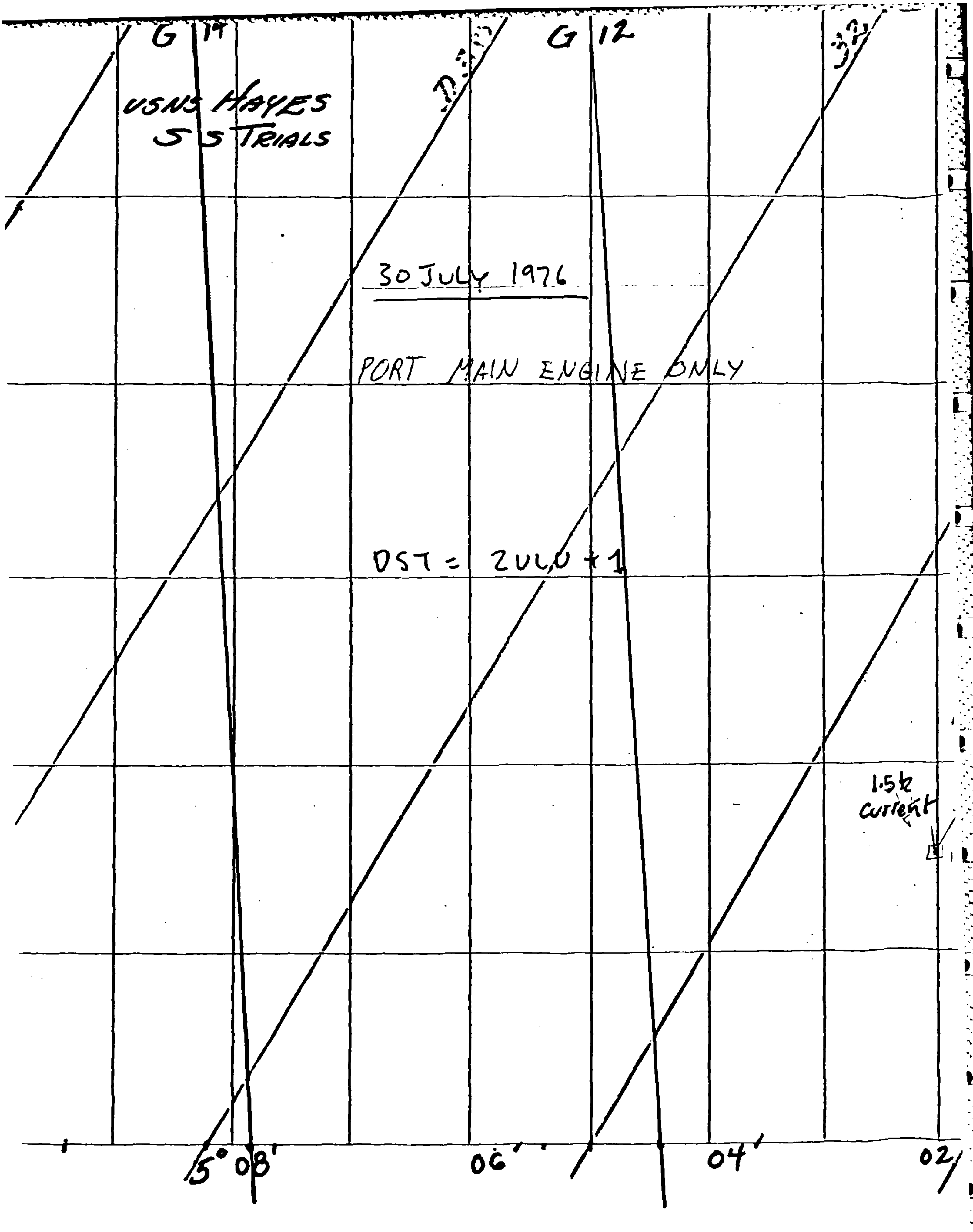
The auxiliaries as they are configured now can be used in the direct control mode up to about sea state 3. The programmed mode from the bridge is not very effective at all. The inconvenience of using the direct mode is that bridge commands must be relayed by phone to the engine control station for action, and this can, and did, result in considerable difficulty in maintaining ship's course owing to the delay in effecting changes requested in propulsive power.

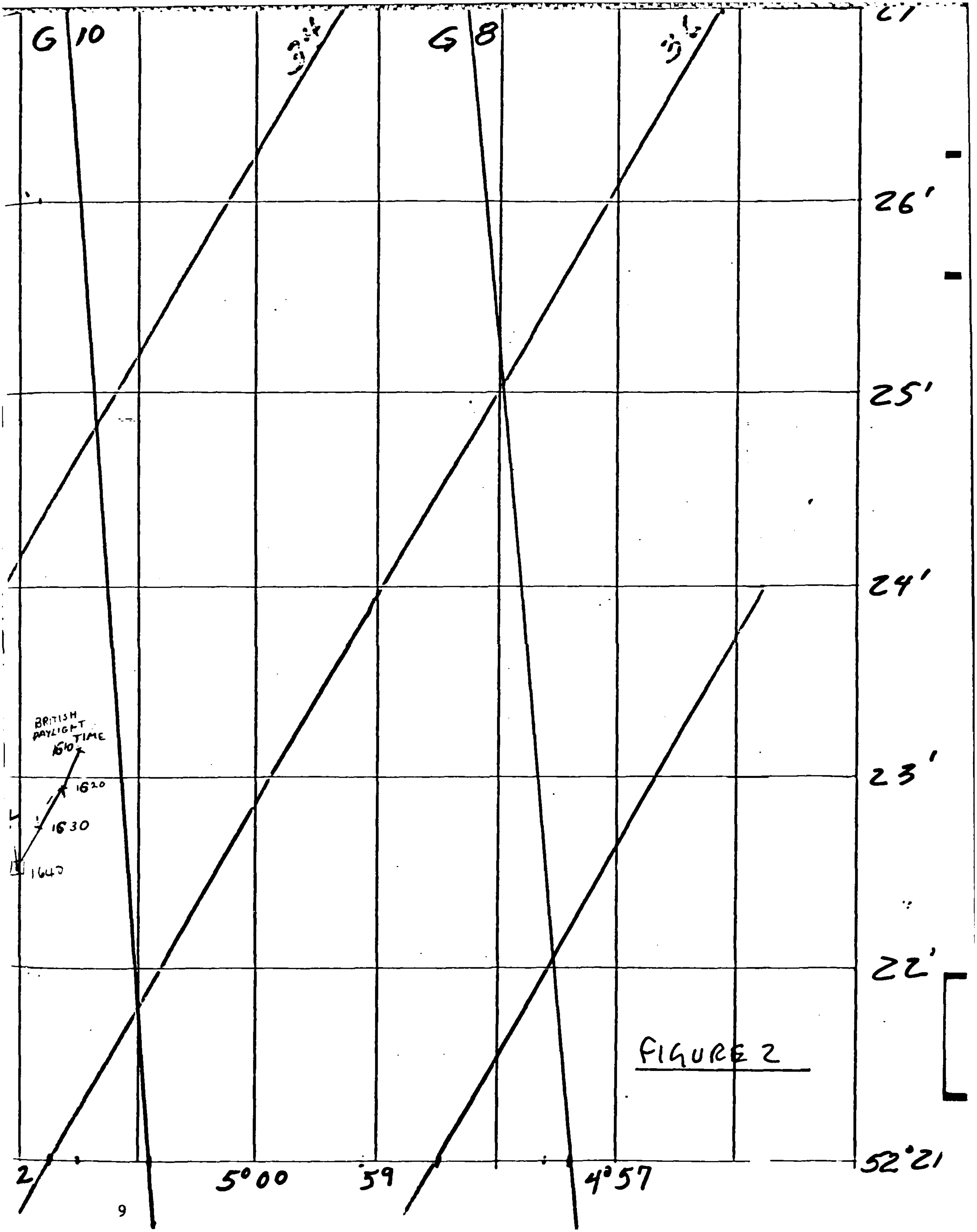
During the time the auxiliary engines were operating the main engines were allowed to idle to accumulate eight hours in the idling mode.

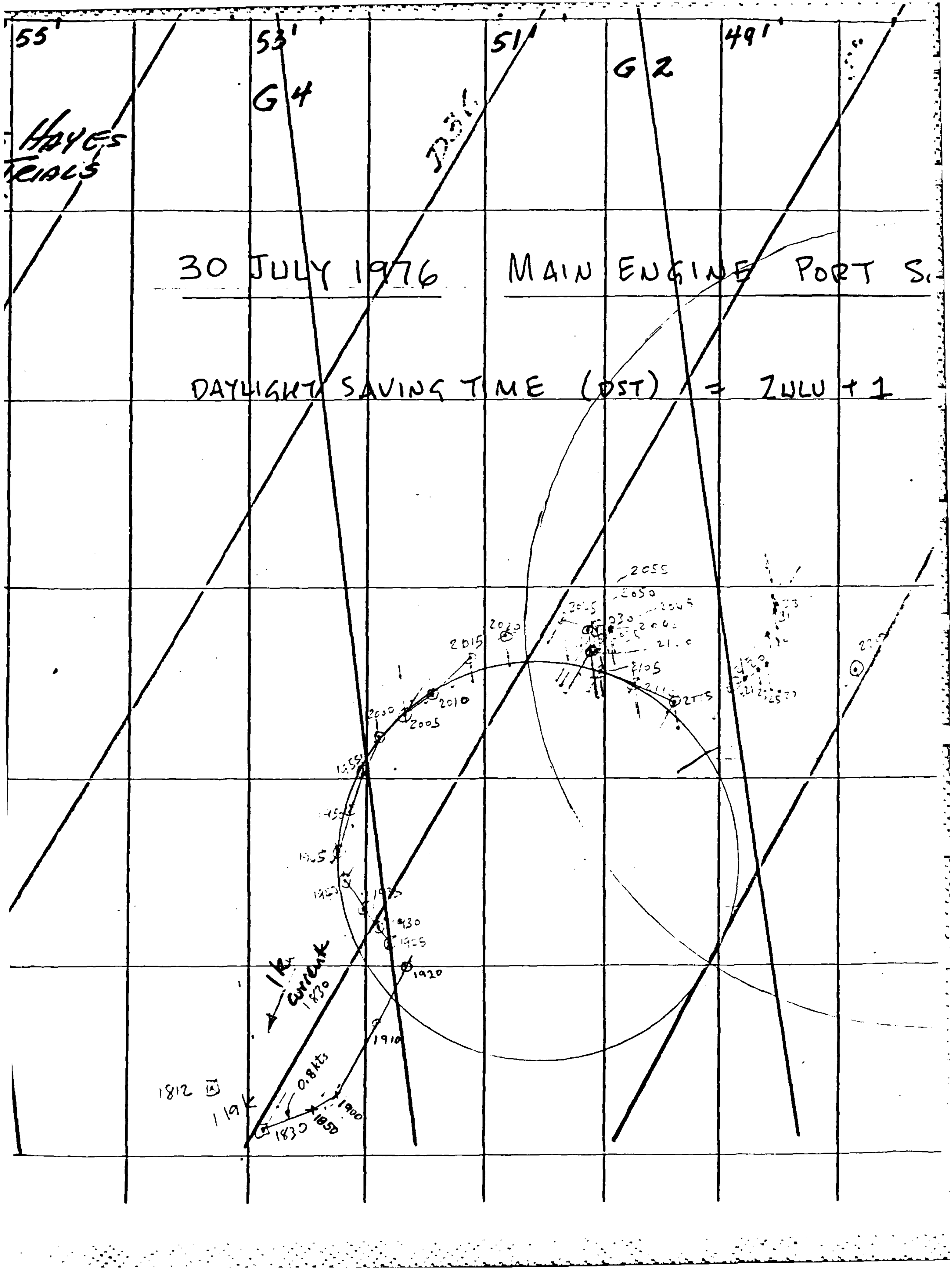
At the end of the first eight hour idling period the main engines were loaded down in order to make smoke. Smoke was not at all severe and was of such short duration that it was not timed.

One Main Engine

The first test with the main engines used the port engine only. (Figures 2 and 3). It was found that propeller pitches less than 10° were difficult to achieve using the programmed mode from the bridge. Increments of pitch less than 1/2° are achievable using the direct mode but in the programmed mode at


G 14
G 12
USNS HAYES
S S TRIALS
30 JULY 1976
PORT MAIN ENGINE ONLY
DST = ZULU + 1
1.5k current
5° 08'
06'
04'
02


G 10
G 8
26'
25'
24'
23'
22'
52°21
2
5°00
59
4°57
BRITISH DAYLIGHT TIME
1610
1620
1630
1640
FIGURE 2



55'
53'
51'
49'
G 4
G 2
HAYES
TRIALS
DSL
30 JULY 1976
MAIN ENGINE PORT S
DAYLIGHT SAVING TIME (DST) = ZULU + 1
1 kt current
0.8 kts
119K
1812
1830
1850
1900
1910
1920
1925
1930
1955
2000
2005
2010
2015
2020
2055
2050
2105
2115

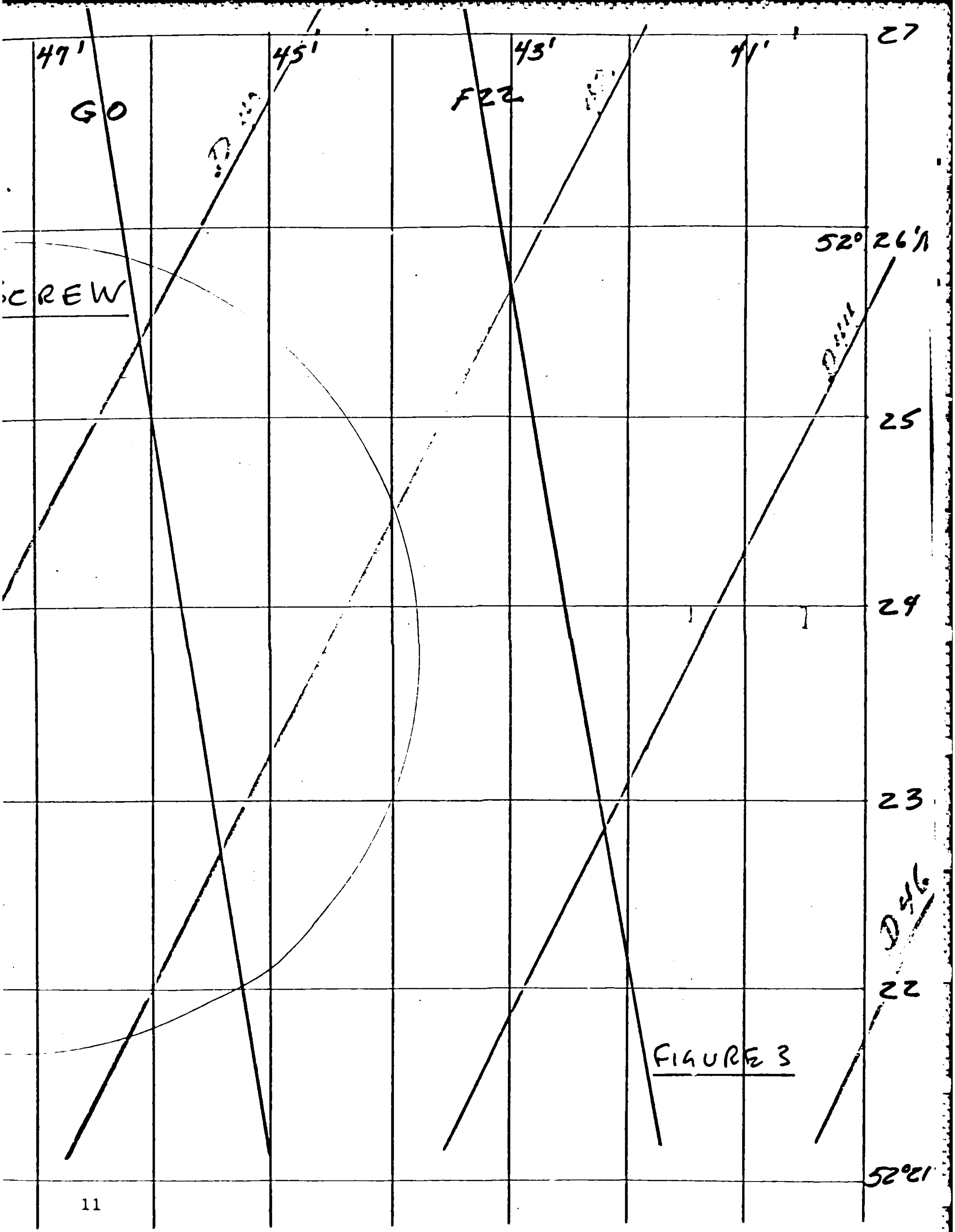


FIGURE 3

The disadvantage of this mode of operation is that the change from left to right turn can sometimes be accompanied by confusion owing to the necessity to reverse pitches and rudders from one extreme to the other in a short period of time. Also the method of operating is clearly inefficient in the use of fuel oil.

CONCLUSIONS

Conclusions of the slow-speed trials cruise are:

a. the ship performs well under both engine operation at higher sea states
b. for sea states between four and five both engines can be used with some success provided the pitch on one screw is reversed compared to that on the other. In some instances it is possible to maneuver in the range of the programmed control where revolutions vary and in some cases it is preferred to maneuver in the range where the pitch varies.
c. For sea states less than four the present alternatives of using the auxiliary engines or one main engine alone presented some difficulties. and it would be desirable to consider some other means of propulsion at the low end of the power curve.

Additional comments on the auxiliary engines are as follows.

a. Power provided by the auxiliaries in the programmed mode does not permit their use under any but very calm sea conditions.
b. In the direct mode they achieve some degree of success limited only by the temperatures of the exhaust manifold and lubrication oil.
c. Using either mode of control and the auxiliary engines it is difficult to hold the ship, which has a large sail area, against any reasonable wind force.
d. The trials were conducted without the NRL search fish or cable in the water which would almost double the resistance.
e. Operation of the present small engines would be greatly improved if the direct mode of control were installed on the bridge.
f. Because of the small size of the engines there is reluctance on the part of the master to stop and cool down the main engines for fear of having insufficient power to call upon in an emergency situation.
g. If the main engines were kept warm by cooling water from the auxiliaries being run through them, the objection to shutting them down altogether might not be so serious.
h. Simple modifications to the present auxiliary engines such as the replacement of the ejectors can result in a marginally increase in power, however, this would still not close the gap in power between the auxiliaries and the main engines.
i. The biggest single problem in using the small engines is in the power gap which exists between the top end of the auxiliaries and the lower end of the main engines. This power gap results in overheating of the auxiliaries or coking up of the main engines; or poor maneuverability, whenever only one main engine is used.

25

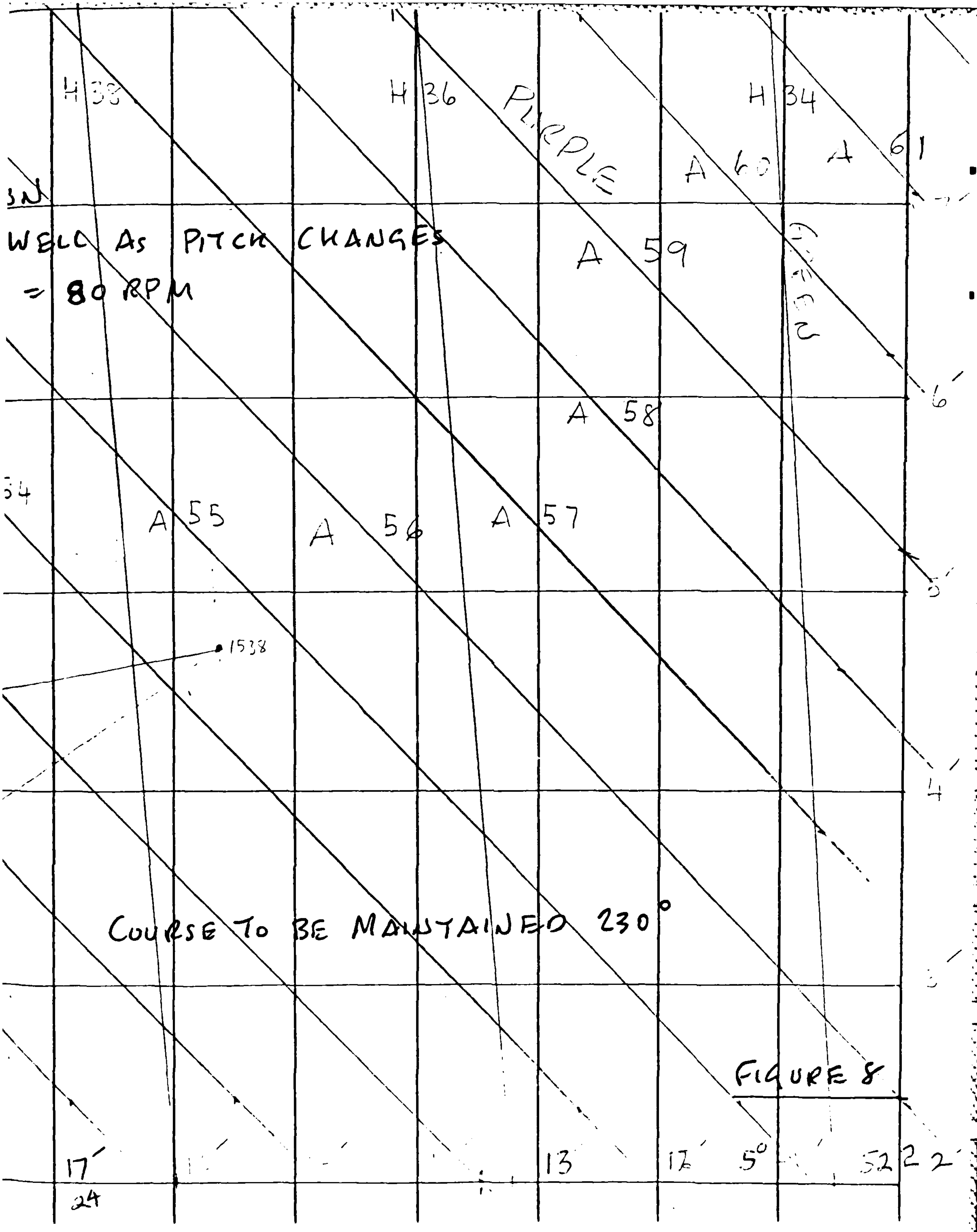
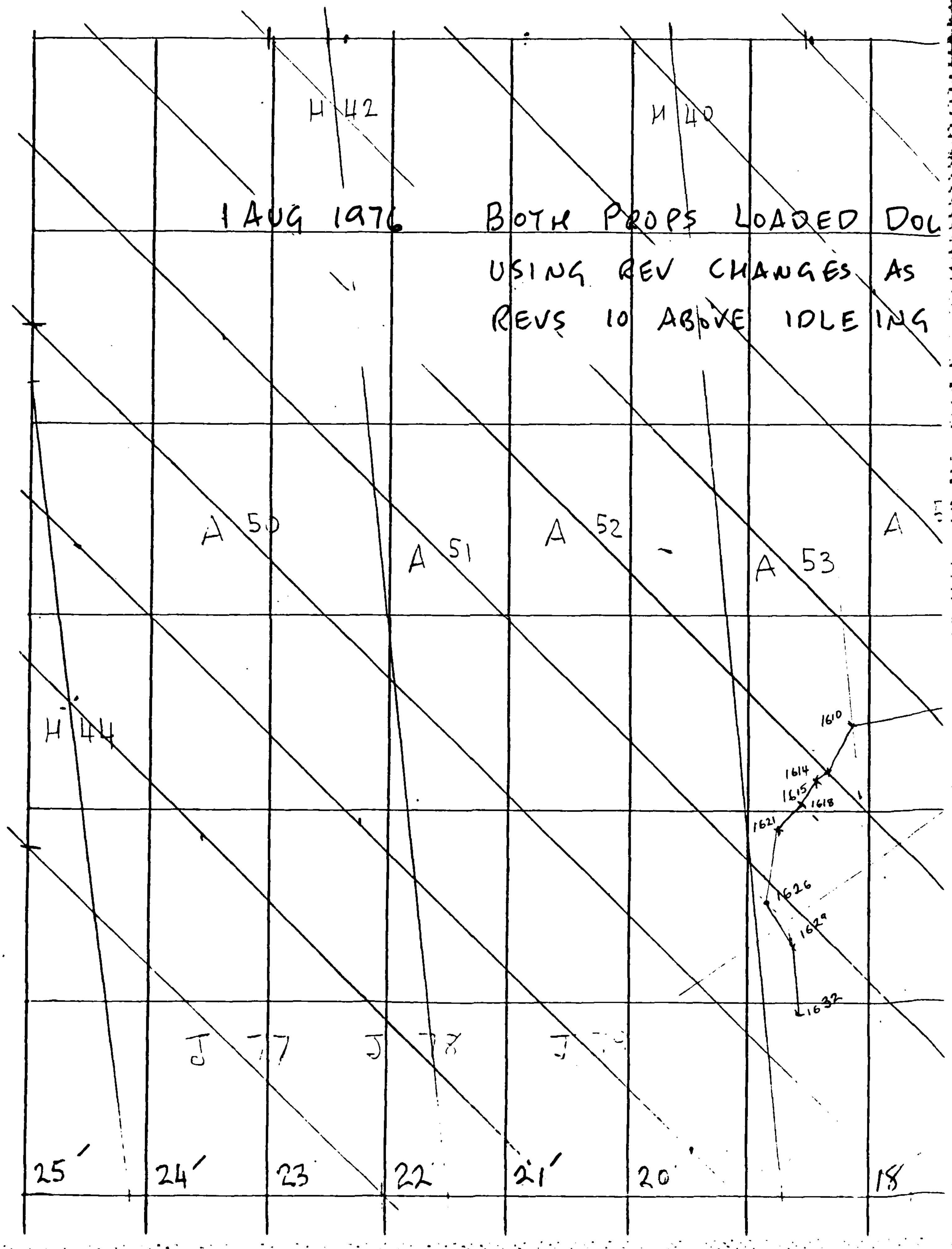
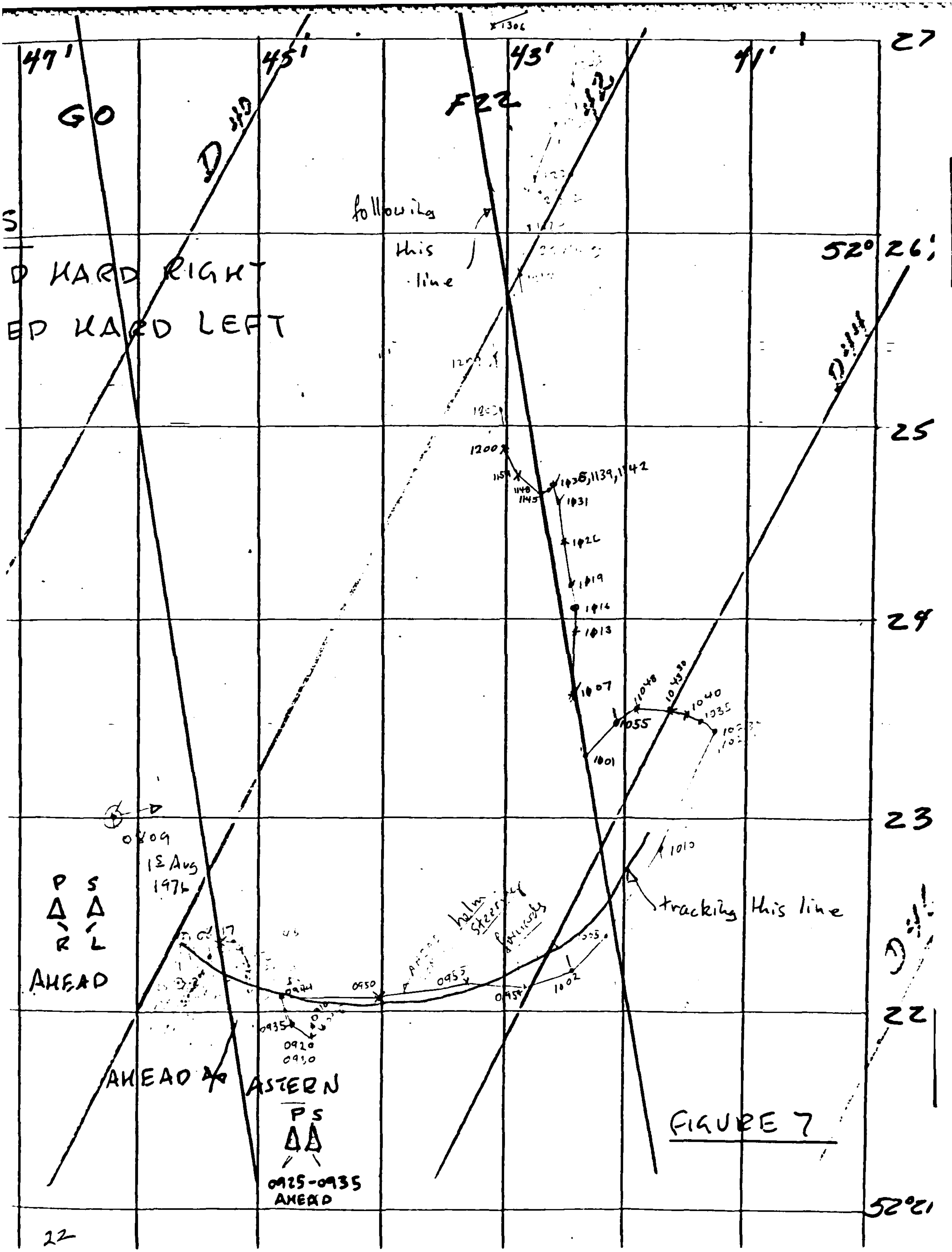

H 38
H 36
PURPLE
H 34
A 60
A 61
WELL AS PITCH CHANGES
= 80 RPM
A 59
A 58
A 55
A 56
A 57
1538
COURSE TO BE MAINTAINED 230°
6
4
17
24
13
5°
2

FIGURE 8

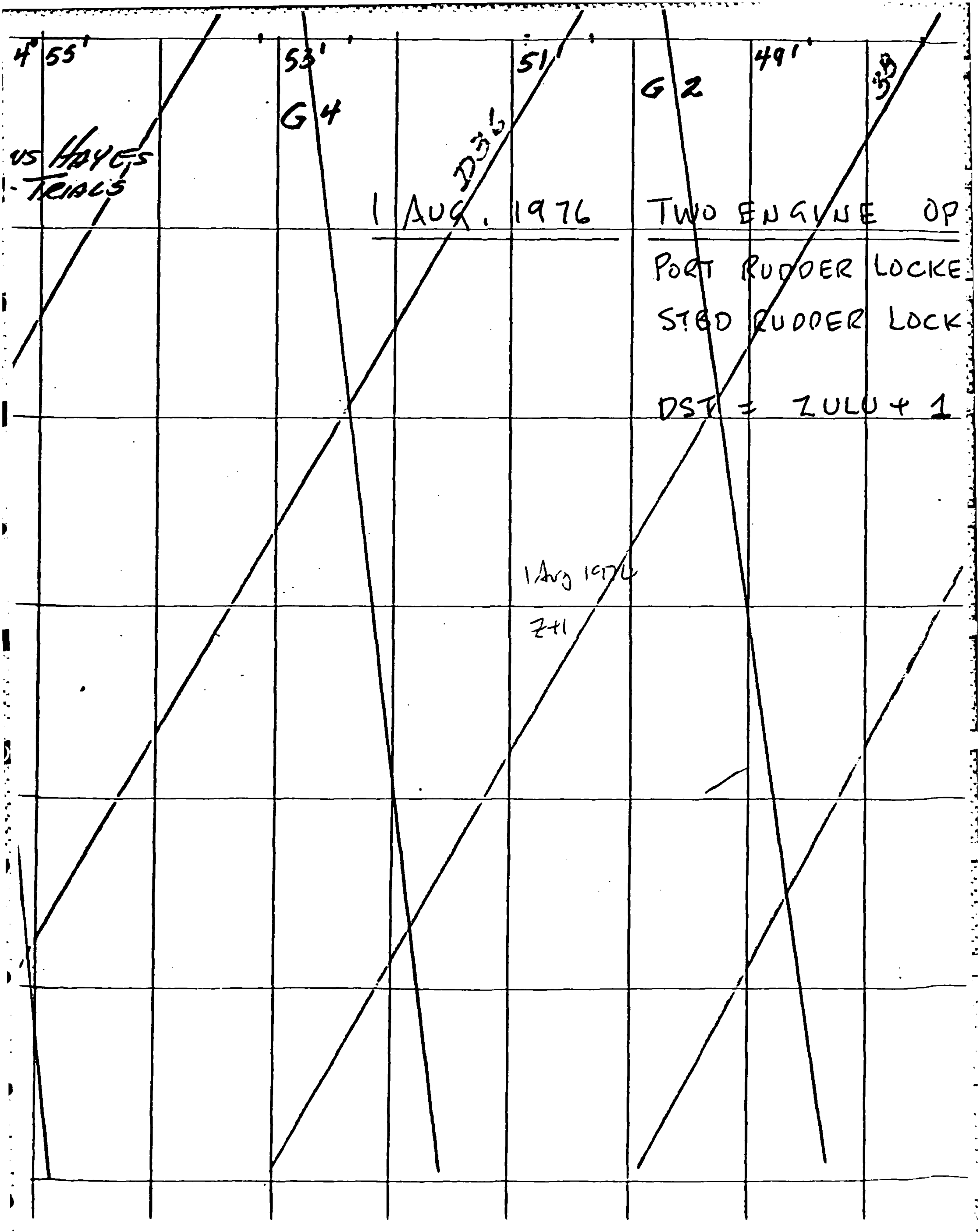


H 42
H 40
1 AUG 1976 BOTH PROPS LOADED DOL
USING REV CHANGES AS
REVS 10 ABOVE IDLEING
A 50
A 51
A 52
A 53
A
H 44
1610
1614
1615
1618
1621
1626
1629
1632
J 77
J 78
J
25
24
23
22
21
20
18



47'
45'
43'
41'
27
GO
D
F22
following this line
52° 26
D HARD RIGHT
ED HARD LEFT
25
1200
1139, 1142
1145
1031
1026
1019
1016
1013
24
1007
1048
1040
1035
1055
1001
23
0809
13 Aug 1976
P S
R L
AHEAD
1010
tracking this line
helm steering
0950
0955
1002
0935
0920
0930
22
AHEAD to ASTERN
P S
0925-0935 AHEAD
52°21

FIGURE 7


4° 55'
53'
51'
49'
G 4
G 2
US HAYES
-TRIALS
1 AUG. 1976
TWO ENGINE OP
PORT RUDDER LOCKE
STBD RUDDER LOCK
DST = ZULU + 1
1 Aug 1976
Z+1

Upon going back to steering on pitch and rudder together there was reasonable success in the plotter's ability to maintain the desired track.

During this sequence of two engine trials the wind was 30 knots, sea 10 feet early in the trial;and wind 15 knots, sea 5 feet late in trial.

Next began a series of slow-speed trials using two main engines with both rudders locked. The port rudder was fixed hard right at 35° and the starboard rudder fixed hard left at 35°. Slow speeds were achieved on pitch changes alone but with great difficulty. The additional drag from the locked rudders clearly had little effect on the resistance of the ship at these slow speeds. No significant increase in power was observed that could be attributed to the rudder settings. Engine power being absorbed was still well below 10% of full power. An attempt was made to back the ship along a line with the rudder set in in this manner but this proved to also be not satisfactory. A change in strategy late in this test was found to be helpful. Instead of providing two pitch settings (on port and starboard propellers) to the bridge an average pitch setting was given in addition to a course. The officer on the bridge was then told that he could add from one pitch and subtract from the other an equal amount to achieve the desired rate of turn. (Fig. 7)

Another fixed rudder setting was attempted to increase drag. In this case the port rudder was made hard left and the starboard rudder was set hard right. This combination was found to be no better than the towed-in configuration and added a little more to the confusion in that when the bridge officer moved ahead on pitch of one hull, that hull moved astern.

A return was made to helm steering moving forwards with the officer on the bridge adjusting pitch to maintain course. The ship has difficulty turning under pitch and rudder control when there is a wind. Sea conditions at this time were 15 to 20 knot wind, overcast sky with a slightly choppy sea about five feet high.

At the end of the 24 hours of idling or near idling for the main engines, smoke cleared after 72 minutes. The smoke was never very dense but quite noticeable.

The final test conducted included operating both main engines in a loaded down condition by maintaining the pitch on both screws at maximum and the revolutions at least 10 rpm above idling. Figure 8 shows the result of this test. First starboard then port screws were given an ahead or an astern pitch alternately with rudder compensation to maintain course. The ship was found to be quite maneuverable under this condition of loading which can be used for three weeks with no smoke blowout. Speeds less than 1 knot were achievable. Two quite severe turns were made successfully, one 50° to the left and another 100° to the right. Turning both ways was made at about 8 degrees in 10 seconds.

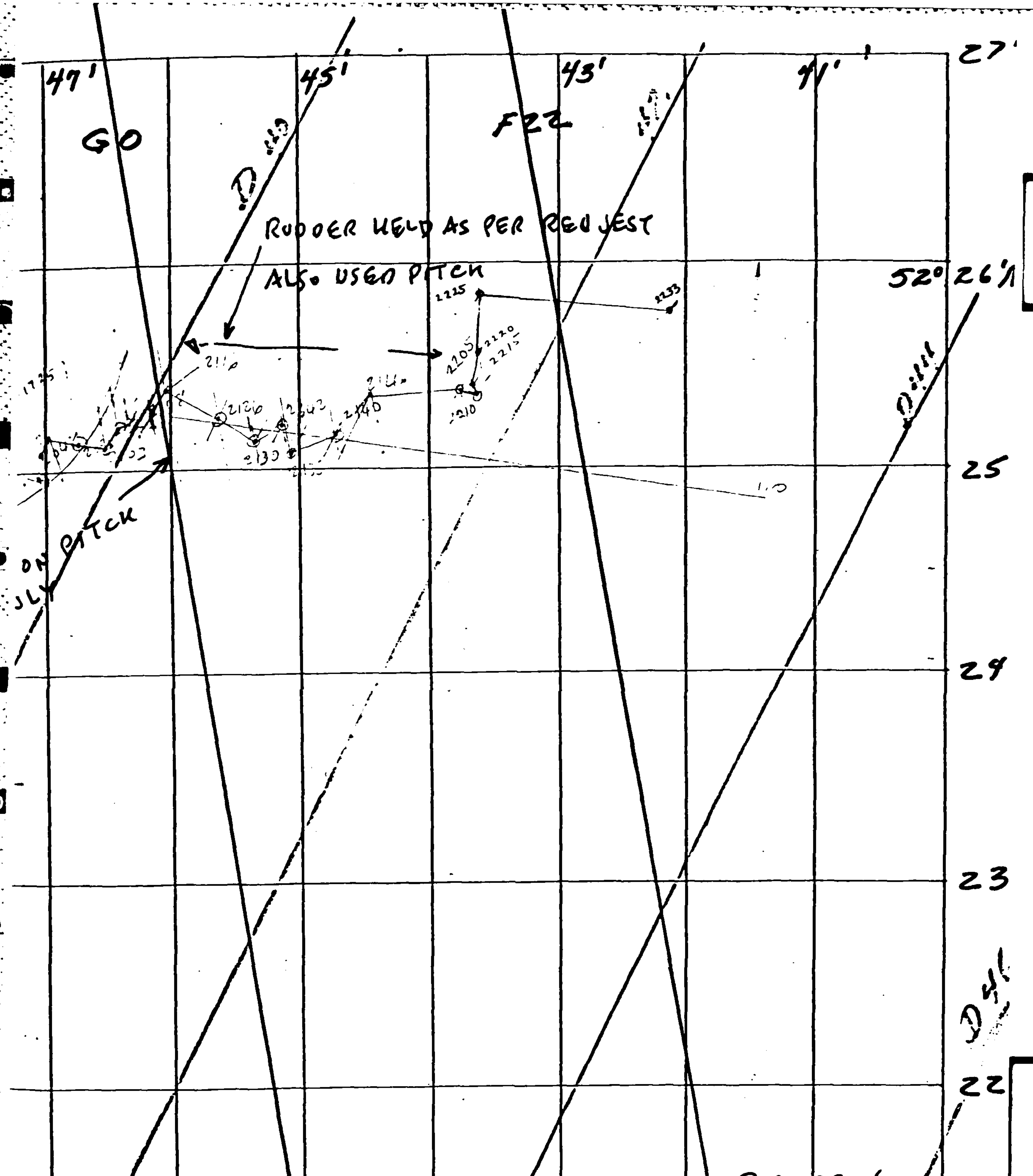
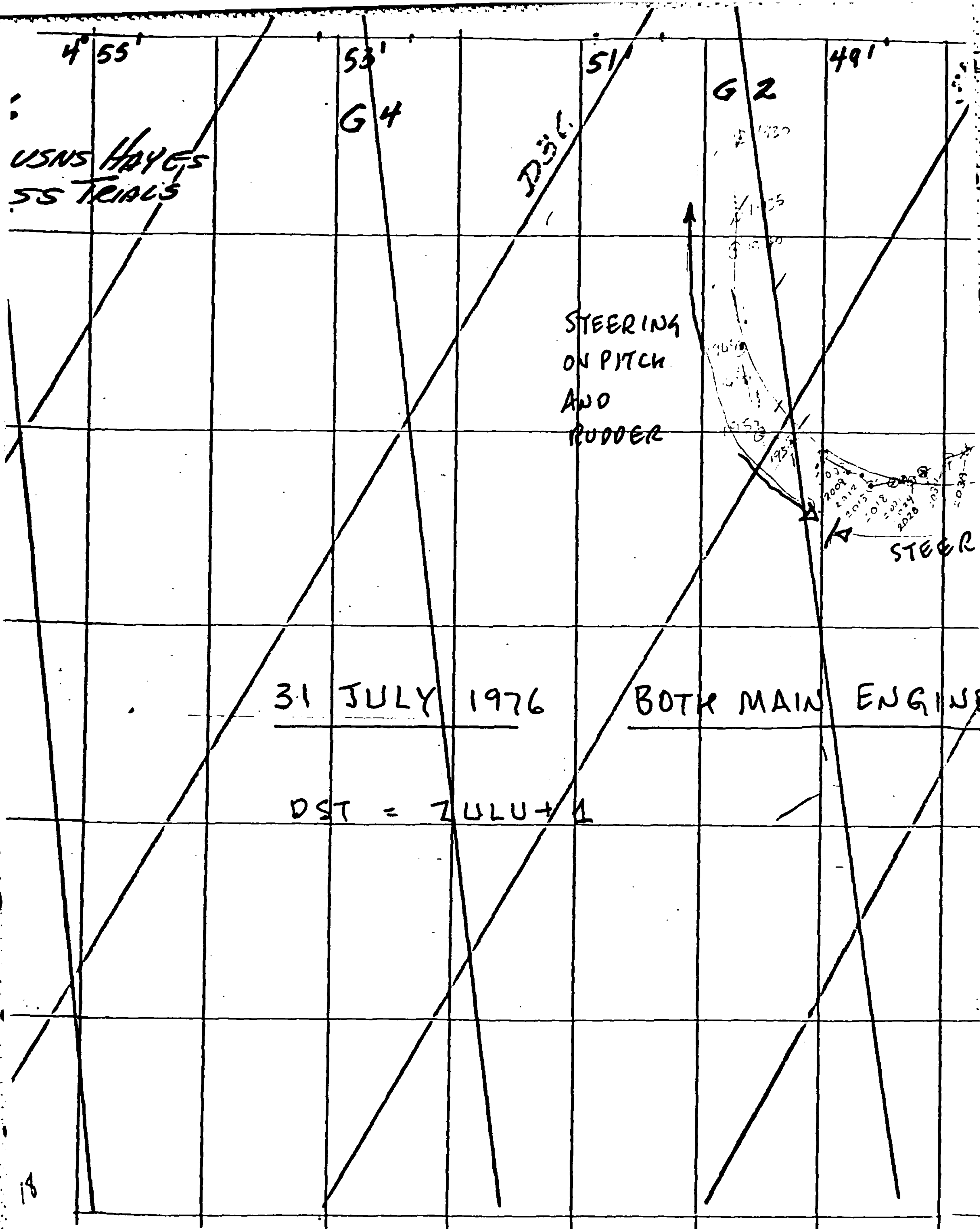

47'
45'
43'
41'
27'
GO
FZZ
RUDDER HELD AS PER REQUEST
ALSO USED PITCH
52° 26'
2225
2233
2205
2220
2215
2210
25
ON PITCH
24
23
22
52°

FIGURE 6


4° 55'
53'
51'
49'
G 4
G 2
USNS HAYES
SS TRIALS
STEERING
ON PITCH
AND
RUDDER
STEER
31 JULY 1976
BOTH MAIN ENGIN
DST = ZULU + 1

18

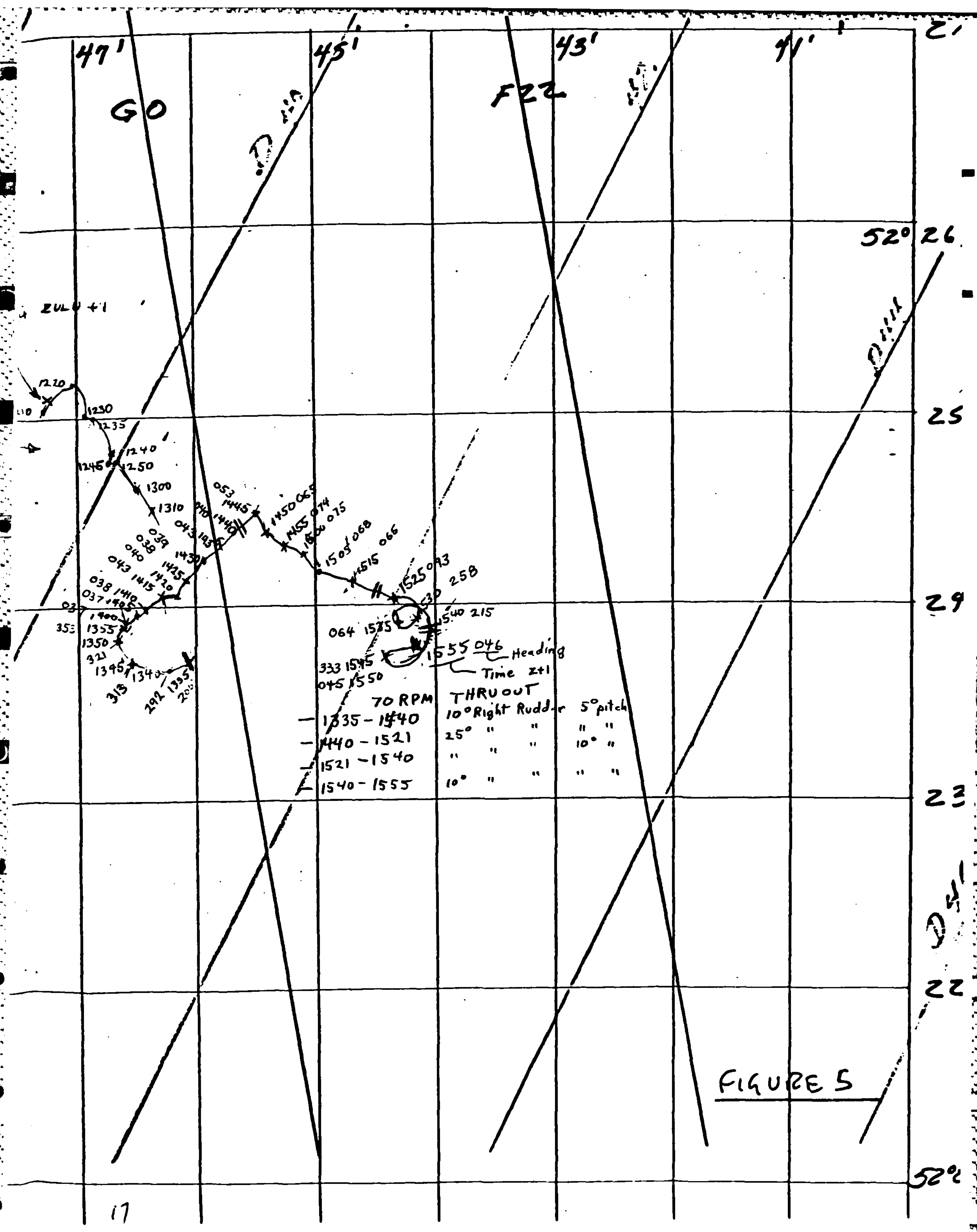
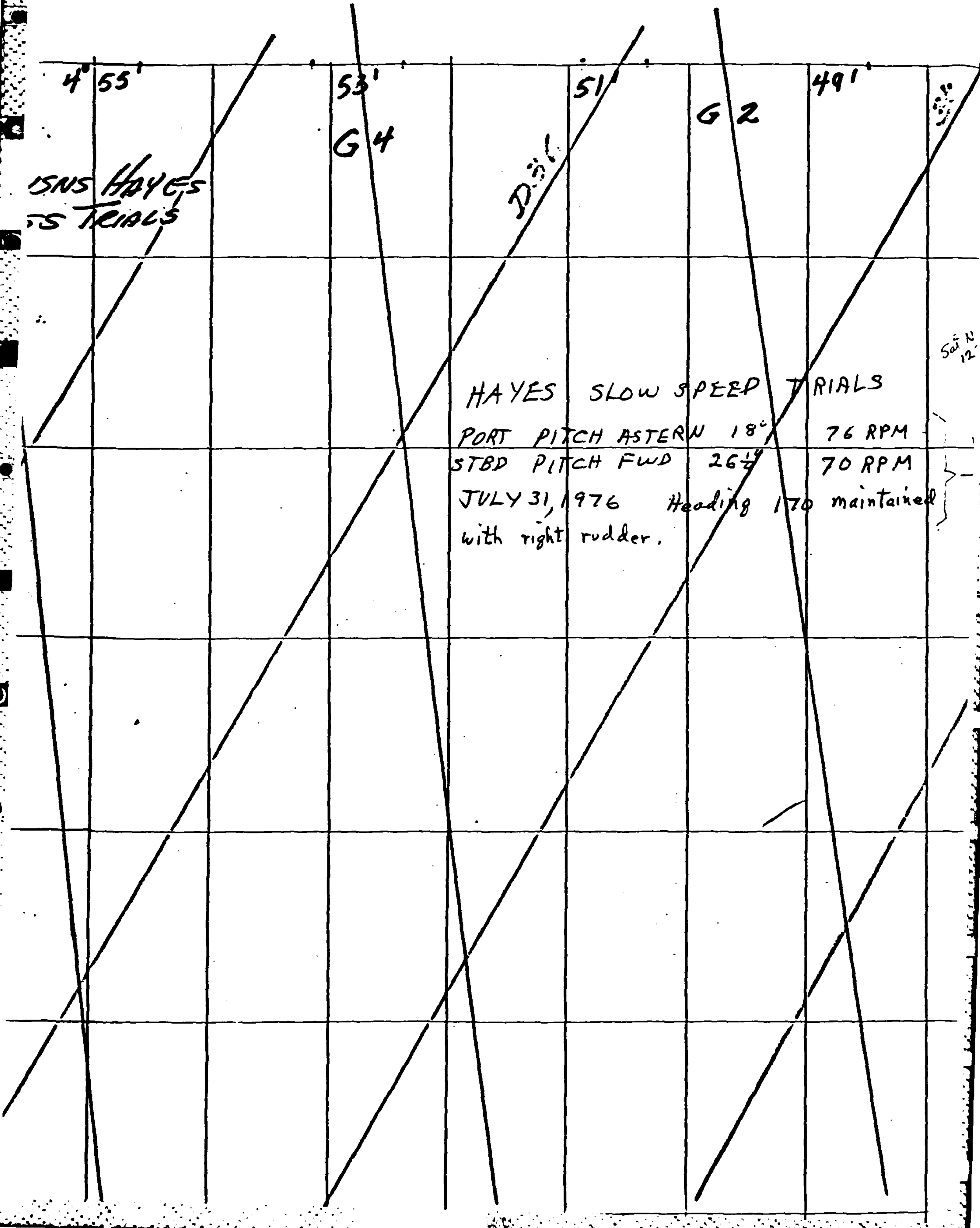

47'
45'
43'
41'
GO
FZZ
52° 26
25
23
22
52°
ZULU +1
1555 046 Heading
Time Z+1
70 RPM THRUOUT
1335 - 1440 10° Right Rudder 5° pitch
1440 - 1521 25° " " " "
1521 - 1540 " " " 10° "
1540 - 1555 10° " " " "

FIGURE 5



4° 55'
53'
51'
49'
G 4
G 2
D.S.
USNS HAYES
TRIALS
HAYES SLOW SPEED TRIALS
PORT PITCH ASTERN 18° 76 RPM
STBD PITCH FWD 26¼ 70 RPM
JULY 31, 1976 Heading 170 maintained with right rudder.

also considering the problem of returning to the site again to resume the search without possibly knowing exactly where the ship was in the first instance.

The next series of trials, the results of which are shown in Figure 5, were conducted using a forward pitch on the starboard screw and an astern pitch on the port screw with rudder compensation to maintain heading.

If was found to be not possible to use this method for blowout since we could not achieve sufficient power output on either forward moving or after-moving screw. The engines required that they be run at 27-1/2° pitch and 130 rpm for smoke clearance. The most which could be reached in this manner without permitting the course to fall away was:

port screw at 76 rpm at 18 degrees pitch astern
starboard screw 68 rpm at 26-1/4° pitch ahead.

The chief engineer agreed that under this condition of about 50% full load, so long as the engines were not in need of blowout to begin with, the ship might be able to run from 18 to 21 days without breaking off to smoke.

This clearly then is one plausible solution, especially for sea conditions around state 5. In this mode the ship performed well along a straight course but there was some confusion during turns (see Figure 5).

When one propeller is thrusting forward while the other is thrusting ahead there will be an inefficient use of fuel but hopefully this could be tolerated for periods up to 3 weeks.

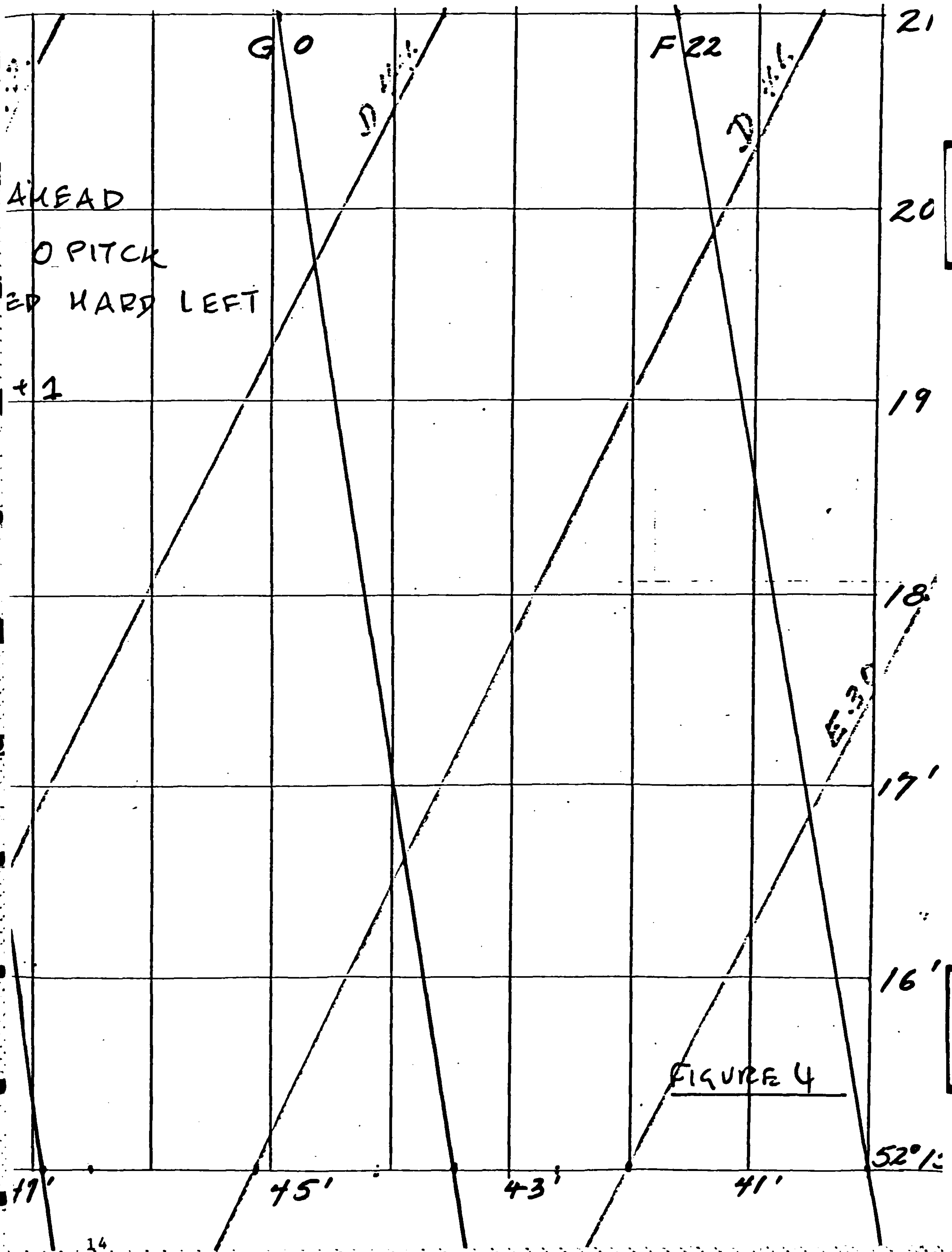
During the reversed ~~thruster~~ thrust trials the wind was 30 knots and the sea 10 foot waves. The heading the ship attempted to maintain was 170°.

In relating pitch to power it was found from the computer analysis that 27-1/2° forward pitch on the main engines was equivalent to 10.6% of full power. The maximim astern pitch of 17-1/2° developed 8.16% of full power. Both of the values above are given for rpm at idling speed. All pitch variations then lie within the power range less than 20% of full power according to this, but there is some question as to the validity of the computer results.

Two Main Engines

The remainder of the trials used both main engines during a 24 hour period when they were practically near to idling.

An interesting feature of the two engine trials included attempting to steer using propeller pitch changes only while holding the rudder on the centerline. This proved to be not very satisfactory owing to the fact that a fixed pitch condition resulted in a turning circle which was fixed. This track could only be adapted to a straight line by continually updating the request for pitch changes. (Figure 6)


G 0
F 22
D
AHEAD
0 PITCH
ED HARD LEFT
+1
E 30
21
20
19
18
17'
16'
52°
47'
45'
43'
41'
FIGURE 4

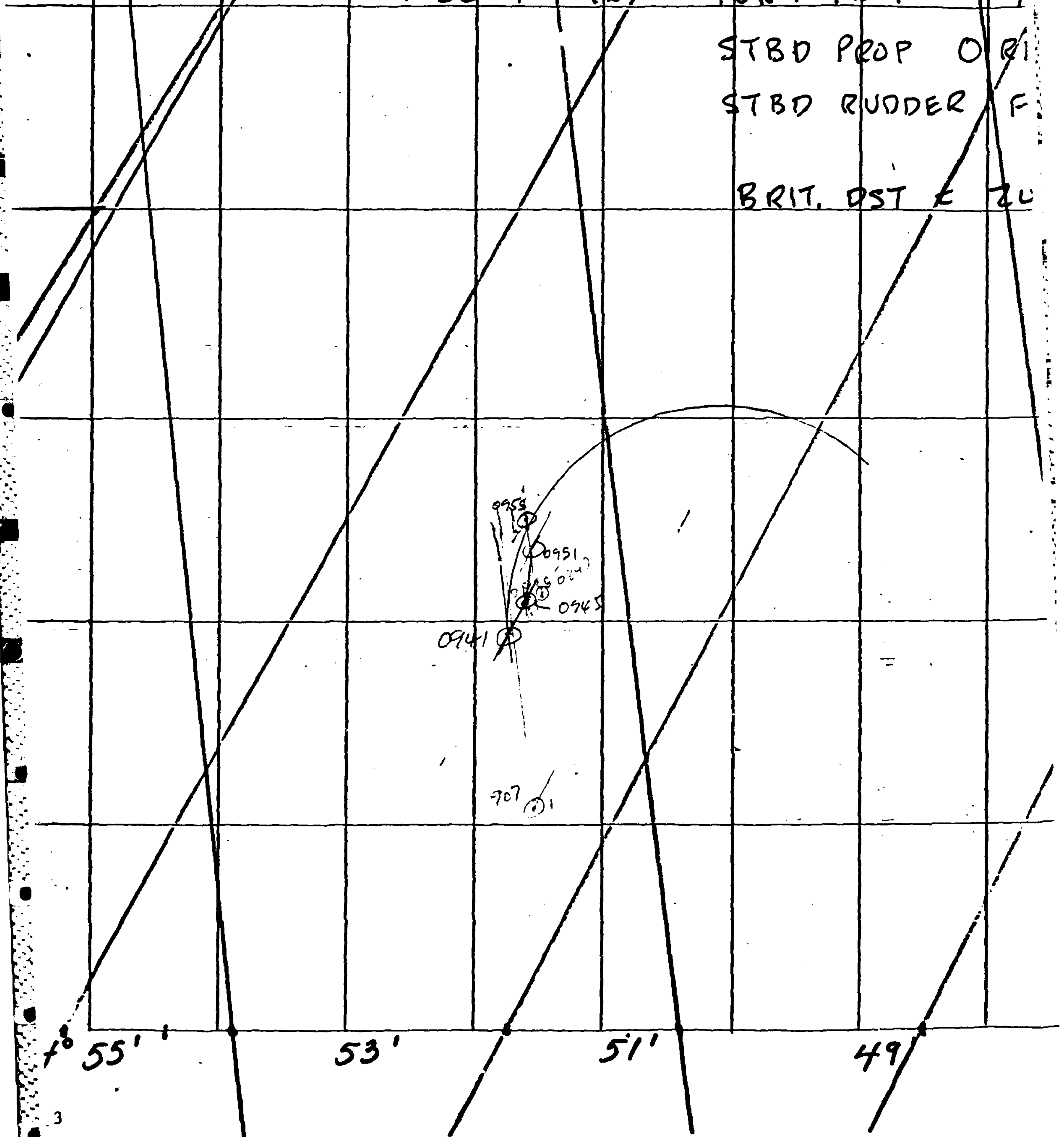
USNS HAYES
SS TRIALS

31 JULY 1976 PORT PROP ONLY

STBD PROP O[illegible]

STBD RUDDER F

BRIT. DST [illegible]



low pitches the control system goes into a hunting oscillation. After some practice, however, it seemed to be possible for the helmsman to use the program lever for all pitch settings. Circular maneuvers and turns were practiced at very slow speeds.

During the first trials using one engine the other engine on the starboard side was set at zero pitch and allowed to idle at 70 rpm. Later the starboard propeller was stopped entirely - see Figure 4. This action seemed to have little effect.

If one engine is used at a time the duration between smoke periods can effectively be doubled. Using one engine, initially resulted in extremely poor maneuverability and an attempt to turn through 180° was abandoned. One engine operation is possible in low sea states but search patterns would have to accommodate reversing over alternate lines instead of turning the ship at the end of each survey line.

One of the tests using one propeller only included locking the starboard rudder hard left at 35°

The ship was found to perform better on these later trials (including straight courses and maneuvering) when using both rudders or with one rudder locked. Steering is very poor whether using both rudders or with one of them locked, when going astern. Astern modes should not be used when operating on one engine alone.

On one engine with the shaft rotating at 90 rpm and the pitch set at 27-1/2° the ship turns at 12° in 10 seconds going forwards. Turns both to the left and the right were made at over 1° per second. The turning radius for all turns on one propeller was about one ship length. The weather during the single engine trials was about sea state 4-5 with a 20 knot wind.

At this point the ship was reaching the end of 16 hours of main engine idling and the engines were once more loaded down to clear the smoke. The port stack cleared in 15 minutes and the starboard in 40 minutes. Shaft revolutions of the engines during this period of smoke clearance were 130 rpm.

The conclusion of the one engine trials was that one engine can be used between sea state 3 to sea state 5 in the direct mode.

Disadvantages of the direct mode have already been explained in connection with the auxiliary trials. In addition to this, when the main engines are used, it is necessary to proceed at very close to 3/4 full power for nearly an hour after every 16 hours of operation in order to clear the smoke from the stack. This would place a search operation at a tremendous disadvantage not only from the point of view of time spent in the desmoking operation but

j. A criteria on the amount of power needed from auxiliary engines is the amount needed to maintain the minimum turn rate in sea states up to 4-5. While the present auxiliaries can turn at this rate in sea states 3 they cannot manage it in any higher sea states primarily because of the wind which accompanies the sea.

k. An increase in the power of the auxiliaries might present some difficulty at the lower end of the auxiliary scale; however the auxiliaries are loaded down at the end of each search line when the ship is turned through 180° every two hours and problems are not expected.

l. A summary of the auxiliary engine test is given in Figure 9. The Figure shows the engines are overloaded, since pitch is 25° (16° is design max) and exhaust temperature is up to 556° (lube oil temp is also high) but horsepower delivered is only 100 each (H.P. from the computer analysis is questionable, however.)

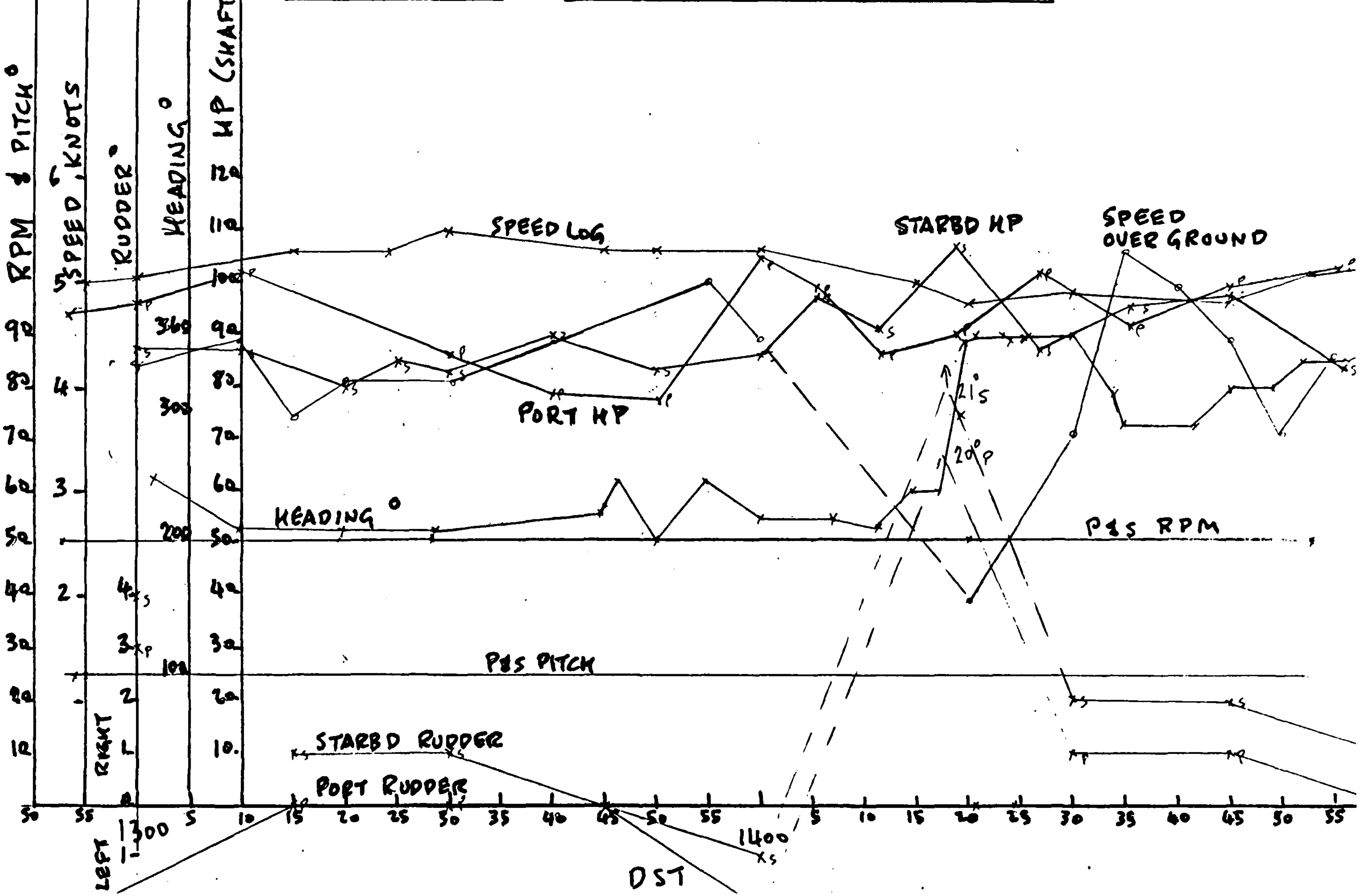
26

27

FIGURE 9.

SUMMARY OF AUXILIARY ENGINE TEST (DIRECT MODE)

30 JULY 1976 1300 - 1500 DST (ZULU + 1)



MAY 1962 EDITION
GSA FPMR (41 CFR) 101-11.6

UNITED STATES GOVERNMENT

Memorandum

8410-101-GOT:erl

TO	:	Code 1210	DATE: 18 May 1976
VIA	:	Codes 8400, 8004, 8000	
FROM	:	Code 8410	

SUBJECT: Op Plan for Slow-Speed Trials Cruise (SST)

REF : (a) 8410-68:GOT:erl of 30 March 1976

ENCL : (1) Operation Plan for Slow-Speed Trials Cruise 29 July - 1 Aug 1976

1. The operational plan, enclosure (1) to reference (a), has been revised owing to a change in ship schedule.

2. Enclosure (1) is the operational plan for USNS HAYES Slow-Speed Trials Cruise 29 July - 1 August 1976. Ten copies of the Op Plan are provided for further distribution to the Master, USNS HAYES and MSCLANT.

GEOFFREY O. THOMAS
Head, Ocean Engineering Branch

Copy w/encl
Code 8000
Code 8004
Code 8400
Code 1200
Code 8412

APPENDIX I

OPERATION PLAN FOR

USNS HAYES SLOW-SPEED TRIALS CRUISE

29 July - 1 Aug 1976

Objective - General

To establish slow-speed operational and maneuverability characteristics of HAYES in a seaway.

Objective - Specific

To investigate slow-speed operational and maneuverability characteristics of the HAYES using:

(a) auxiliary engines

(b) one main engine

(c) two main engines.

Engine operational conditions during slow-speed tows to be evaluated include;

(a) programmed shaft speed and propeller pitch control

(b) direct control of shaft revolutions and pitch

(c) manual control of shaft revolutions and pitch.

Evaluate other engine variables, to determine the effect on ship performance at slow-speed, including:

(a) increase of auxiliary engine revolutions

(b) decrease of idling speed on main engines

(c) effects of idling on main engine carbonization

(d) decarbonization times required after periods of idling.

Means to increase ship propulsive power requirements will be studied including:

(a) independent control of each rudder to increase drag.

Participation

Slow-speed trials are to be conducted by the Ocean Technology Division of the Naval Research Laboratory.

Sponsor

The task is being performed for the Assistant Secretary of the Navy (Research and Development) and funded by the Office of Naval Research. NRL Problem Number 84 G05-20 has been assigned to this task.

Sailing Schedule

Depart:	Glasgow, Scotland	29 July 1976
Arrive:	Milford Haven, Wales	1 Aug 1976

Location

The location for the slow-speed trials has been selected for convenience enroute between Glasgow, Scotland and Milford Haven, and avoidance of surface ship transit lanes and extremely shallow water. The area is located approximately 50 miles north of Milford Haven: about five hours of sailing time. The operational area is 52^{o}--15' to 52^{o}- 25' north latitude, 4^{o}- 40' to 5^{o}- 00' west longitude. Movement of the HAYES within this operational area will be at the discretion of the Senior Scientist on Board.

Approach

27 July. Scientific Crew (2 people from NRL) leave Washington, D. C. for Glasgow, Scotland.

28 July. Discuss operations with Master and senior officers.

Thur /76 29 July. (Zulu time)

1500 - depart Glasgow, Scotland.

30 July.

1100 - arrive on station - commence slow-speed trials.

During slow-speed trials, the ship will be under bridge navigation. A search pattern will be set by the Senior Scientist on Board to be followed by bridge personnel using fixes determined from the radar (using the 40 mile range setting), or from LORAN C or DECCA scientific navigation equipment. The initial objective of the trial is to determine the engine combination to use for slow-speed operations.

30

1100-1200 - navigate into position to begin slow-speed runs.

1230-1630 - slow speed trials and maneuvers using auxiliary engines only. Programmed, direct and manual control will be used and attempts will be made to increase power provided by the auxiliaries.

1700-2400 - two engine slow-speed trials and maneuvers. In addition to programmed engine control, direct and manual modes will be used to reduce shaft idling speeds below 70 rpm and the pitch of the propellers below 5^{o}. The effect of one shaft running more slowly than the other with rudder compensation, or one shaft reversed from the other, will be evaluated.

31 July

0000 - ship maintains search pattern throughout the night at speeds less than one knot. Scientific crew breaks for the day.

0830 - scientific crew back on duty - resume slow-speed evaluation.

0830-1200 - one main engine (other engine off) slow-speed trials and maneuvers. Programmed, direct and manual controls will be used and the effects of idling speed reduction and pitch variation again will be evaluated.

Independent rudder control to increase drag will be studied.

1200 - begin 3/4 full-power runs to burn off engine carbon.

1330 - resume slow-speed operations.

For the remainder of the slow-speed operations the engine combination will be used which has been selected at this point as being best for the purpose.

1330-1700 - 0.25 knot trails (speed is measured over the ground).

1730-2030 - 0.5 knot trials.

2030-2300 - 1 knot trials.

2300-0100 - 2 knot trials.

1 August

0100-0500 - evaluation and additional runs as necessary.

0500 - depart Ops area.

1000 - HAYES arrives Milford Haven, Wales.

1200 - scientific part departs ship.

31

Measurements

Measurements to be recorded during the slow-speed trials include:

(a) time

(b) a ship large-scale navigational course record will be kept

(c) speed from the bridge log

(d) rpm on both shafts from the bridge display

(e) pitch of both propellers from the bridge repeater

(f) torque on both shafts from engine control station display

(g) angle on both rudders

Facilities and Equipment

The support ship to be evaluated is the USNS HAYES (T-AGOR-16).

Equipment to be Installed

None

Scientific Crew

The Scientific crew will consist of two people from the Ocean Technology Division, NRL. Other personnel from the Ship Facility Group and Shipboard Computer Group, NRL, will be aboard to assist. The Senior Scientist on Board (SSOB) will be Mr. Geoffrey O. Thomas.

Work Hours Scheduled

The Scientific Crew will be on duty 12 hours per day. Meal times are as follows:

Breakfast	0730-0830
Lunch	1130-1230
Dinner	1630-1730 while in port and 1700-1800 at sea

32

Communications

During this short curise there will be no scientific communications net maintained between NRL and HAYES.

Daily at-sea POSREPS from HAYES will give ship's latitude and longitude information in the usual manner.

Geoffrey O. Thomas

Geoffrey O. Thomas
Head, Ocean Engineering Branch

33

30 July 1976

SHIP'S DECK LOG

APPENDIX II

MSTS FORM 5211-8 (REV. 1-63)

SHIP

USNS HAYES T-

PASSAGE (~~At or~~ from)

GLASGOW, SCOTLAND

ZONE DESCRIPTION

—1

HOURS (1)	COURSE AND SPEED: RPM (2)	GYRO READING (3)	GYRO ERROR (4)	TRUE HEADING (5)	MAG STD (6)	MAG STD (7)	STANDARD COMPASS ERROR: VARIATION (8)	DEVIATION (9)	ERROR (10)
01									
02		178	0	178	185		10W	3E	7W
03									
04		178	0	178	185		10W	3E	7W
05									
OB 06		176	0	176	185		10W ~~176~~	1E	9W
07									
08		174	0	174	183		10W	1E	9W
09									
10		VARIOUS							
11									
12		VARIOUS							
13									
14		VARIOUS							
15									
16		VARIOUS							
17									
18		VARIOUS							
19									
20		VARIOUS							
21									
22		VARIOUS							
23									
24		VARIOUS							

34

POSITION

HOUR	LATITUDE	LONGITUDE
0800	52°24.5'N	05°02'W
1200	52°20'N	05°00'W
2000	52°25'N	05°00'W

TIME:

FORWARD

TIME:

FORWARD

NOON DATA-PREVIOUS 24 HOURS

TOT

01								
02	178	0	178	185		10W	3E	7W
03								
04	178	0	178	185		10W	3E	7W
05								
OB 06	176	0	176	185		176	1E	9W
07								
08	174	0	174	183		10W	1E	9W
09								
10	VARIOUS							
11								
12	VARIOUS							
13								
14	VARIOUS							
15								
16	VARIOUS							
17								
18	VARIOUS							
19								
20	VARIOUS							
21								
22	VARIOUS							
23								
24	VARIOUS							

POSITION

HOUR	LATITUDE	LONGITUDE	
			TIME: FORWARD
0800	52°24.5'N	05°02'W	
1200	52°20'N	05°00'W	TIME: FORWARD
2000	52°25'N	05°00'W	

NOON DATA-PREVIOUS 24 HOURS

STEAMING TIME	DISTANCE	AVER. SPD.	TOT. STEAMING
22h-00m	255	11.6	22h-

SBE 14:00

BILGE SOUNDINGS

BILGES OR TANKS	TIME	INCHES	INCHES	INCHES	INCHES
PORT	0800				
	1600				
STBD.	0800				
	1600				

EXAMINED BY NAVIGATOR (Signature) B [signature]

34

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DATA SHEET

	VOYAGE NUMBER	DATE
T-AGOR-16	SPEED 16-15 TRIALS	30 July 1976
TO OP-AREA		DAY OF WEEK Friday
CHANGED AT (Time)	TO	

WEATHER OBSERVATIONS

WIND		VISIBILITY (MILES)	WEATHER (SYMBOLS)	BAROMETER (INCHES)	TEMPERATURE			CLOUDS			WAVES		SWELL	
DIRECTION (TRUE)	SPEED (KNOTS)				DRY BULB	WET BULB	SEA WATER INJ	AMOUNT (TENTHS)	HEIGHT (FEET)	TYPE	DIRECTION (TRUE)	HEIGHT (FEET)	DIRECTION (TRUE)	HEIGHT (FEET)
(11)	(12)	(13)	(14)	(15)	(16)	(17)	(18)	(19)	(20)	(21)	(22)	(23)	(24)	(25)
260	15	10	2	2991	54	53		8	2000	Sc	260	2	260	3
260	15	10	2	2990	54	53		8	2000	Sc	260	2	260	3
230	10	10	2	2996	57	55		8	2000	Sc	210	2	260	3
230	10	10	3	29.98	61	60		10	2000	Sc	240	2	260	3
230	10	10	2	29.94	58	57		8	3000	Sc	230	2	260	3
020	10	8	2	29.94	58	57		9	3000	Sc	020	2	330	3
020	10	8	3	2994	58	57		10	2000	Sc	020	1	230	3
Lt	Air	10	3	2995	62	61		10	2000	Sc	020	1	—	
280	07	10	3	29.94	59	58		10	2000	Sc	240	1	—	—
280	08	10	3	29.94	56	55		10	2000	Sc	240	1	—	—
330	12	10	2	29.94	56	55		9	2000	Sc	330	1	230	3
330	12	10	2	29.94	56	55		7	3000	Sc.	330	1	230	3

DRAFT			LOAD LINE MARK	
			ARRIVAL	
D	AFT	MEAN	PORT	STARBOARD
			DEPARTURE	
D	AFT	MEAN	PORT	STARBOARD

ALS THIS VOYAGE AS OF NOON | SUN DATA

260	15	10	2	2991	54	53		8	2000	Sc	260	2	260	3
260	15	10	2	2990	54	53		8	2000	Sc	260	2	260	3
230	10	10	2	2996	57	55		8	2000	Sc	210	2	210	3
230	10	10	3	29.98	61	60		10	2000	Sc	230	2	210	3
230	10	10	2	29.94	58	57		8	3000	Sc	230	2	260	3
020	10	8	2	29.94	58	57		9	3000	Sc	020	2	330	3
020	10	8	3	2994	58	57		10	2000	Sc	020	1	230	3
Lt	Airs	10	3	2995	62	61		10	2000	Sc	020	1	—	
280	07	10	3	29.94	54	58		10	2000	Sc	280	1	—	—
280	08	10	3	29.94	56	55		10	2000	Sc	280	1	—	—
320	12	10	2	29.94	56	55		9	2000	Sc	320	1	230	3
330	12	10	2	29.94	56	55		7	3000	Sc.	330	1	230	3

DRAFT			LOAD LINE MARK	
			ARRIVAL	
D	AFT	MEAN	PORT	STARBOARD
			DEPARTURE	
D	AFT	MEAN	PORT	STARBOARD

ALS THIS VOYAGE AS OF NOON			SUN DATA	
TIME	DISTANCE	DIST. TO GO	SUNRISE *(Time)*	SUNSET *(Time)*
00	255		0534	2115

				TANK SOUNDINGS						OTHER			
				FP		AP				CHLKR			
INCHES	INCHES	INCHES	INCHES	FT.	IN.	FT.	IN.	FT.	IN.	FT.	IN.	FT.	IN.

37

APPROVED BY MASTER *(Signature)*

[signature]

31 July 1976

SHIP'S DECK LOG

MSTS FORM 5211-8 (REV. 1-63)

SHIP
USNS HAYES T-AG

PASSAGE (At ~~or from~~)
OP-AREA

ZONE DESCRIPTION
−1

HOURS	COURSE AND SPEED						STANDARD COMPASS ERROR		
HOURS	RPM	GYRO READING	GYRO ERROR	TRUE HEADING	MAG STD	MAG STG	VARIATION	DEVIATION	ERROR
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
01									
02		160	0	160	169		9W	0	9W
03									
04		270	0	270	281		9W	2W	11W
05									
06		310	0	310	318		9W	1E	8W
07									
08		005	0	005	015		9W	1E	8W
09									
10		VARIOUS							
11									
12		VARIOUS.							
13									
14		170	0	170	180		9W	1W	10W
15									
16		Various							
17									
18		Various							
19									
20		VARIOUS							
21									
22		VARIOUS							
23									
24		180	0	180	190		9W	1E	10W

POSITION			
HOUR	LATITUDE	LONGITUDE	TIME: FORWARD
0800	52-10.5 N	14-53 W	
1200	52°-24.5 N	04°-46' W	TIME: FORWARD
2000	52°-25' N	04°-50' W	

NOON DATA-PREVIOUS 24 HOURS | TOTA

38

02		160	0	160	169		9W	0	9W
03									
04		270	0	27?	281		9W	2W	11W
05									
06		310	0	310	318		9W	1E	8W
07									
08		005	0	005	015		9W	1E	8W
09									
10		VARIOUS							
11									
12		VARIOUS							
13									
14		170	0	170	180		9W	1W	10W
15									
16		Various							
17									
18		Various							
19									
20		VARIOUS							
21									
22		VARIOUS							
23									
24		180	0	180	190		9W	1E	10W

POSITION

HOUR	LATITUDE	LONGITUDE	
			TIME: FORWARD
0800	52-10.5 N	14-53 W	
1200	53°-24.8 N	04°-46' W	TIME: FORWARD
2000	52°-25 N	04°-50' W	

NOON DATA-PREVIOUS 24 HOURS			TOTA
STEAMING TIME	DISTANCE	AVER. SPD.	STEAMING
24 h	85	3.5	1d 22h

BILGE SOUNDINGS

BILGES OR TANKS	TIME	INCHES	INCHES	INCHES	INCHES
PORT	0800				
	1600				
STBD.	0800				
	1600				

EXAMINED BY NAVIGATOR *(Signature)* B. Jackson

DATA SHEET

	VOYAGE NUMBER	DATE
...OR-16	SPEED TRIALS	31 JULY 1976
TO		DAY OF WEEK: SATURDAY
CHANGED AT *(Time)*	TO	

40

WEATHER OBSERVATIONS

WIND					TEMPERATURE			CLOUDS			WAVES		SWELL	
DIRECTION (TRUE) (11)	SPEED (KNOTS) (12)	VISIBILITY (MILES) (13)	WEATHER (SYMBOLS) (14)	BAROMETER (INCHES) (15)	DRY BULB (16)	WET BULB (17)	SEA WATER INJ (18)	AMOUNT (TENTHS) (19)	HEIGHT (FEET) (20)	TYPE (21)	DIRECTION (TRUE) (22)	HEIGHT (FEET) (23)	DIRECTION (TRUE) (24)	HEIGHT (FEET) (25)
350	14	10	1	2996	54	53		1	3000	Cu	350	2	330	3
000	14	10	1	2996	54	53	54	1	3000	Cu	350	2	330	3
330	16	10	1		53	50		1	3000	Cu	330	4	330	3
340	18	10	1	29.99	57	52	59	1	3000	Cu	340	4	340	5/6
350	20/25	10	2	30.02	56	55		6	3000	SC	350	5	350	6
000	20/25	10	2	30.06	58	57	57	5	3000	SC	000	5	350	6
350	20/25	10	2	3010	57	57		5	3000	Cu	350	5	350	6
350	25/30	10	2	3010	[illegible]	58		3	3000	Cu	350	5	350	6
350	18	10	1	30.13	54	55		1	3000	Cu	350	5	350	6
360	14	10	1	30.14	54	53		1	3000	Cu	360	5	360	6
000	15	10	1	30.16	54	53		3	3000	Cu	000	4	000	6
000	15	10		30.18	53	52		3	3000	Cu	000	4	000	6

DRAFT			LOAD LINE MARK	
			ARRIVAL	
...ARD	AFT	MEAN	PORT	STARBOARD
			DEPARTURE	
...ARD	AFT	MEAN	PORT	STARBOARD

...OTALS THIS VOYAGE AS OF NOON	SUN DATA

40

350	14	10	1	2996	54	53		1	3000	Cu	350	2	330	3
000	14	10	1	2996	54	53	54	1	3000	Cu	350	2	330	3
330	16	10	1		53	50		1	3000	Cu	330	4	330	3
340	18	10	1	29.99	57	56	59	1	3000	Cu	340	4	340	5/6
350	20/25	10	2	30:02	56	55		6	3000	SC	350	5	350	6
000	20/25	10	2	30:06	58	57	57	5	3000	SC	000	5	350	6
350	20/25	10	2	3010	58	57		5	3000	Cu	350	5	350	6
350	25/30	10	2	3010	60	58		3	3000	Cu	350	5	350	6
350	18	10	1	30.13	54	55		1	3000	Cu	350	5	350	6
360	14	10	1	3014	54	53		1	3000	Cu	360	5	360	6
000	15	10	1	30:16	54	53		3	3000	Cu	000	4	000	6
000	15	10		30:18	53	52		3	3000	Cu	000	4	000	6

DRAFT			LOAD LINE MARK	
			ARRIVAL	
ARD	AFT	MEAN	PORT	STARBOARD
			DEPARTURE	
ARD	AFT	MEAN	PORT	STARBOARD

OTALS THIS VOYAGE AS OF NOON			SUN DATA	
ING TIME	DISTANCE	DIST. TO GO	SUNRISE (Time)	SUNSET (Time)
4-00	340		0538	2116

				TANK SOUNDINGS						OTHER			
				FP		AP				CHLKR			
INCHES	INCHES	INCHES	INCHES	FT.	IN.	FT.	IN.	FT.	IN.	FT.	IN.	FT.	IN.

41

APPROVED BY MASTER (Signature)

[signature]

12-71

SHIP'S DECK LOG

MSTS FORM 5211-8 (REV. 1-63)

SHIP

USNS HAYES T-

PASSAGE (At or from)

OP-AREA

ZONE DESCRIPTION

-1

HOURS (1)	COURSE AND SPEED: RPM (2)	GYRO READING (3)	GYRO ERROR (4)	TRUE HEADING (5)	MAG STD (6)	MAG STG (7)	STANDARD COMPASS ERROR: VARIATION (8)	DEVIATION (9)	ERROR (10)
01									
02		225	0	225	236		9W	2W	11W
03									
04		040	0	040	051		9W	2W	11W
05									
06		270	0	270	282		9W	1W	10W
07									
08			VARIOUS						
09									
10			VARIOUS						
11									
12			VARIOUS						
13									
14		223	0	223	235		9W	3W	12W
15									
16									
17									
18									
19									
20									
21									
22									
23									
24									

POSITION

HOUR	LATITUDE	LONGITUDE
0800	52-22N	07-47W
1200	52°-34'N	04°-48'W
2000		

TIME: FORWAR

TIME: FORWAR

NOON DATA-PREVIOUS 24 HOURS

STEAMING TIME | DISTANCE | AVER SPD

TOT

STEAMIN

X2

42

02		225	0	225	236		9W	2W	11W
03									
04		040	0	040	051		9W	2W	11W
05									
06		270	0	270	282		9W	1W	10W
07									
08		VARIOUS							
09									
10		VARIOUS							
11									
12		VARIOUS							
13									
14		223	0	223	235		9W	3W	12W
15									
16									
17									
18									
19									
20									
21									
22									
23									
24									

POSITION			
HOUR	LATITUDE	LONGITUDE	TIME: FORWAR
0800	52-22 N	04-47 W	
1200	53°-34' N	04°-48' W	TIME: FORWAR
2000			

NOON DATA-PREVIOUS 24 HOURS			TOT
STEAMING TIME	DISTANCE	AVER. SPD.	STEAMIN
24h	64	2.7	9d-33

BILGE SOUNDINGS

BILGES OR TANKS	TIME	INCHES	INCHES	INCHES	INCHES
PORT	0800				
	1600				
STBD.	0800				
	1600				

EXAMINED BY NAVIGATOR (Signature)

43

1 Aug 76

DATA SHEET

	VOYAGE NUMBER	DATE
AGOR - 16	SPEED TRIALS	1 AUGUST 1976
TO		DAY OF WEEK SUNDAY
CHANGED AT *(Time)*	TO	

WEATHER OBSERVATIONS

WIND					TEMPERATURE			CLOUDS			WAVES		SWELL	
DIRECTION (TRUE) (11)	SPEED (KNOTS) (12)	VISIBILITY (MILES) (13)	WEATHER (SYMBOLS) (14)	BAROMETER (INCHES) (15)	DRY BULB (16)	WET BULB (17)	SEA WATER INJ (18)	AMOUNT (TENTHS) (19)	HEIGHT (FEET) (20)	TYPE (21)	DIRECTION (TRUE) (22)	HEIGHT (FEET) (23)	DIRECTION (TRUE) (24)	HEIGHT (FEET) (25)
340	8	10	1	3018	53	52		2	3000	Cu	350	2	350	2
340	8	10	1	3019	53	52		2	3000	Cu	350	2	350	2
340	8	10	1	30.21	55	53		1	3000	Cu	340	2	350	—
300	8	10	2	30.22	55	52	59	6	3000	Sc Cu	300	2	—	—
250	15	10	2	30:22	59	58		7	3000	SC	250	2	—	—
250	15/20	10	2	30:22	61	60		6	3000	SC	250	3	—	—
50	25/20	8	3	3020	57	57		10	2500	SC	250	4	250	4

DRAFT			LOAD LINE MARK	
			ARRIVAL	
	AFT	MEAN	PORT	STARBOARD
			DEPARTURE	
	AFT	MEAN	PORT	STARBOARD

340	8	10	1	3018	53	52		2	3000	Cu	350	2	350	2
340	8	10	1	3019	53	52		2	3000	Cu	350	2	350	2
340	8	10	1	30.21	55	53		1	3000	Cu	340	2	350	—
300	8	10	2	30.[illegible]	55	52	59	6	3000	Sc Cu	300	2	—	—
250	15	10	2	30:22	59	58		7	3000	SC	250	2	—	—
250	15/20	10	2	30:22	61	60		6	3000	SC	250	3	—	—
50	15/20	8	3	3020	57	57		10	2500	SC	250	4	250	4

DRAFT			LOAD LINE MARK	
			ARRIVAL	
	AFT	MEAN	PORT	STARBOARD
			DEPARTURE	
	AFT	MEAN	PORT	STARBOARD

LS THIS VOYAGE AS OF NOON			SUN DATA	
TIME	DISTANCE	DIST. TO GO	SUNRISE (Time)	SUNSET (Time)
-00	404		0543	

				TANK SOUNDINGS						OTHER			
				FP		AP				CHLKR			
INCHES	INCHES	INCHES	INCHES	FT.	IN.	FT.	IN.	FT.	IN.	FT.	IN.	FT.	IN.

45

APPROVED BY MASTER (Signature)

END

FILMED

8-85

DTIC